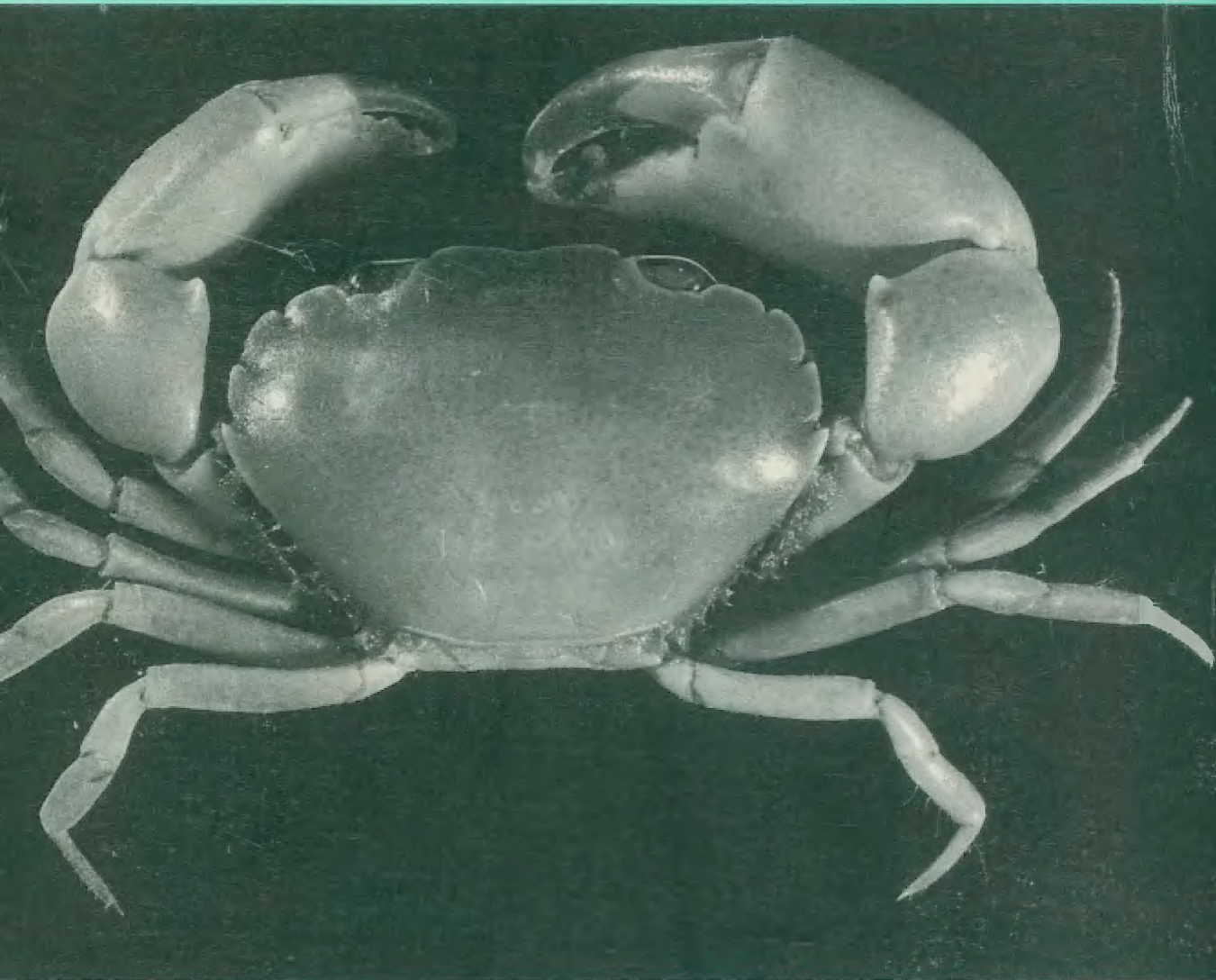


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DARDANUS IMBRICATUS (H. MILNE EDWARDS) AND DESCRIPTIONS OF THREE NEW SPECIES OF DARDANUS (DECAPODA, ANOMURA, DIOGENIDAE)

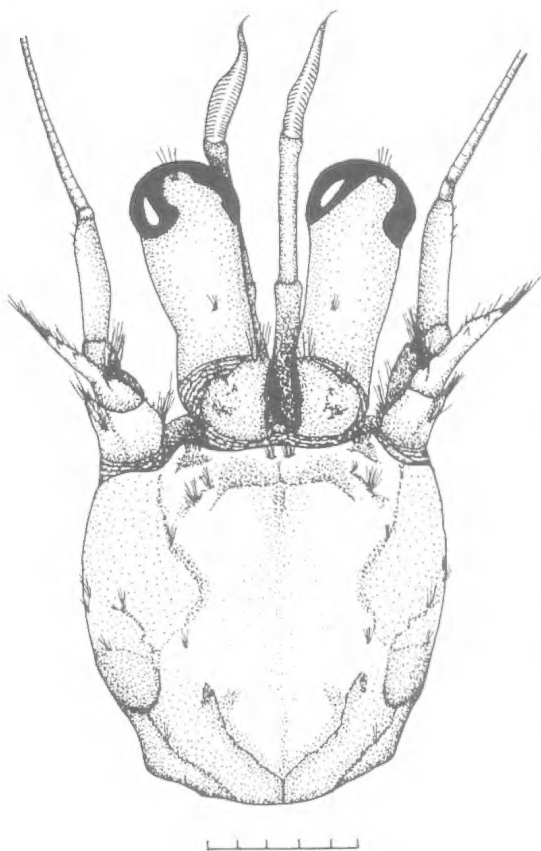
S.D. COOK

Cook, S.D. 1989 11 13: *Dardanus imbricatus* (H. Milne Edwards) and descriptions of three new species of *Dardanus* (Decapoda, Anomura, Diogenidae). *Mem. Qd Mus.* 27(2): 111-122. Brisbane. ISSN 0079-8835.

Three new hermit crab species of *Dardanus* — *D. callichela*, *D. corrugatus* and *D. squarrosus* — are described. All fit the original description of *Dardanus imbricatus* (H. Milne Edwards, 1848). As the holotype of *D. imbricatus* is presumed lost a neotype is erected and a redescription given. All species are compared to the little known *D. undulatus* (Balss, 1921). Species are separated on eye-stalk length and characteristic sculpturing on the outer surfaces of the left cheliped and third left leg.

□ Crustacea, Anomura, Diogenidae, *Dardanus*, new species.

S.D. Cook, Queensland Museum, PO Box 300, South Brisbane, Queensland 4101, Australia; 29 November, 1988.



The collections of the Queensland Museum contain two species of *Dardanus* which fit H. Milne Edwards' (1848) description of *Pagurus imbricatus*. In an attempt to clarify the situation, examination of as much material as possible was undertaken. This revealed another two species closely related to each other, agreeing with Milne Edwards' description but differing from the preceding two species by having long eye-stalks. The description and figure of *Dardanus undulatus* (Balss, 1921) show features similar to some of the present material so examination of the type specimen was undertaken. Characters unique to the group of species included here, and features that can be used to separate the species from each other are given in the general discussion at the end of the paper.

Measurements given are of shield length measured in mid-line. Line drawings were done with the aid of a *camera lucida*. Abbreviations used are: AM Australian Museum, Sydney, Australia. BM British Museum (Natural History), London, United Kingdom. MNHN Museum National d'Histoire Naturelle, Paris, France. NRS Naturhistoriska Riksmuseet, Stockholm, Sweden. NTM Northern Territory Museum of Arts and Sciences, Darwin, Australia. QM Queensland Museum, Brisbane, Australia. WAM Western Australian Museum, Perth, Australia.

***Dardanus imbricatus* (H. Milne Edwards, 1848)**
(Figs 1, 2, 6A)

FIG. 1. *Dardanus imbricatus* (H. Milne-Edwards). Shield and cephalic appendages. Neotype, ♀ (11.6mm), NTM Cr.3444. (Scale = 5.0mm).

Pagurus imbricatus H. Milne Edwards, 1848, p.61; Miers, 1876, p.66; 1884, p.185, 264; Hutton, 1882, p.264; Filhol, 1886, p.424.

?*Pagurus imbricatus*: Henderson, 1888, p.57; Ortmann, 1894, p.30.

Dardanus imbricatus: McNeill, 1968, p.31; Haig and Ball, 1988, p.165.

Not *Dardanus imbricatus* Rathbun, 1910, p.556, pl.49, fig.3. (= *Pagurus peruenis* Balss, 1921, p.21).

MATERIAL EXAMINED

NEOTYPE: NTM Cr.3444 ♂ (11.6mm), Casuarina Beach, Darwin, 12°20.85'S, 130°52.80'E, storm debris, 22/1/1986, C.Hood.

OTHER MATERIAL: AM P18937 ♂ (11.7mm), off Carnarvon W. Aust., 24m, May 1972, A.Nickol; QM W10515 ♂ (6.6mm), NW Shelf, 19°56.9'S, 117°53.5'E, 42-43m, 18/2/1983, T.Ward R.V.*Soela* CSIRO; QM W10516 ♂ (11.9mm), NW Shelf, 19°28.4'S, 118°55.1'E, 37-38m, 25/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10517 ♀ (9.6mm) NW Shelf, 19°45.8'S, 117°52.1'E, 52m, 2/9/1983, T.Ward R.V.*Soela* CSIRO; QM W10519 ♀ (3.4mm), NW Shelf, 19°56.8'S, 117°53.5'E, 44m, 25/6/1983, T.Ward R.V.*Soela* CSIRO; QM W10524 ♂ (7.0mm), ♀ (4.3mm), NW Shelf, 19°29.6'S, 118°52.2'E, 40m, 25/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10525 2♂ (5.4-9.3mm), ♀ (4.5mm), NW Shelf, stn 48, 20°25.4'S, 116°02.6'E, 38m, 14/10/1983, I.Poiner CSIRO; QM W10526 ♂ (7.0mm), NW Shelf, 19°58.9'S, 117°51.3'E, 40m, 22/4/1983, T.Ward R.V.*Soela* CSIRO; QM W10528 3♂ (3.0-8.1mm), 2♀ (3.0-3.5mm), NW Shelf, 19°56.9'S, 117°53.6'E, 43m, 18/2/1983, T.Ward R.V.*Soela* CSIRO; QM W10531 ♂ (ca 8.0mm), NW Shelf, 19°29.6'S, 118°51.7'E, 40-41m, 25/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10532 2♀ (3.7-5.2mm), NW Shelf, 19°58.3'S, 117°49.4'E, 43m, 25/6/1983, T.Ward R.V.*Soela* CSIRO; QM W10533 ♂ (3.6mm), NW Shelf, 19°56.7'S, 117°53.6'E, 40m, 26/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10534 ♂ (6.1mm), ♀ (4.1mm), NW Shelf, 19°56.7'S, 117°53.6'E, 41m, 26/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10535 ♂ (6.4mm), ♀ (8.0mm), NW Shelf, 19°30.8'S, 118°49.4'E, 38m, 30/8/1983, T.Ward R.V.*Soela* CSIRO; QM W10536 ♀ (5.4mm), NW Shelf, 19°58.9'S, 117°51.7'E, 42m, 27/8/1983, T.Ward R.V.*Soela* CSIRO; QM W10539 2♀ (5.2-6.0mm), NW Shelf, 19°29.4'S, 118°52.4'E, 38m, 25/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10540 ♂ (6.8mm), NW Shelf, 19°29.7'S, 118°52.1'E, 38-39m, 25/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10541 2♂ (3.6-6.1mm), ♀ (6.9mm), NW Shelf, 19°29.6'S, 118°52.2'E, 36m, 25/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10542 ♂ (3.1mm), NW Shelf, 19°29.6'S, 118°52.5'E, 39-40m, 28/6/1983, T.Ward R.V.*Soela* CSIRO; QM W10543 ♂ (3.5mm), ♀ (4.1mm), NW Shelf, 19°29.5'S, 118°52.2'E, 37m, 24/10/1983, T.Ward R.V.*Soela* CSIRO; QM W10545 ovig. ♀ (8.9mm), NW Shelf, stn 2, 7/10/1983, I.Poiner CSIRO; QM W10547 ♂ (5.7mm), NW Shelf, 19°45.7'S, 117°52.0'E, 54m, 20/2/1983, T.Ward R.V.*Soela* CSIRO; QM W10548 ♂ (6.1mm), NW Shelf, 19°56.8'S, 117°53.4'E, 42m, 22/4/1983, T.Ward R.V.*Soela* CSIRO; NTM Cr.6581 ♀ (6.0mm), juv., NW Shelf, 19°59.0'S, 117°51.2'E, 40m, 22/4/1983, R.V.*Soela* CSIRO; WAM 1069-86 ♂ (9.5mm), NW Shelf, stn 2, 7/10/1983, I.Poiner CSIRO; NTM Cr.3058

♂ (6.8mm), ovig. ♀ (6.5mm), Fog Bay, Northern Territory, 20m, 12/7/1985, I.Archibald; WAM 1066-86 ♀ (8.1mm), Darwin, N. Australia, trawled, Sept.1965, E.Barker; NTM Cr.4074 ♂ (11.9mm), Gulf of Carpentaria, north of Groot Eylandt, *Gemini* stn AP, 13°30'S, 136°30'E, 15-16/8/1976, P.Elder N.T.Fish. Dept; QM W10501 ♂ (5.6mm), Gulf of Carpentaria, stn S301, 00.30-01.00 hrs trawl, 11m, 14/11/1977, I.Poiner CSIRO; AM P16994 4♂ (7.9-11.4mm), Gulf of Carpentaria, *Rana* stn 571, 16°30.35'S, 139°45.30'E, trawled, 22m, Jan. 1964, CSIRO Prawn Survey; BM 1882:7 ♂ (9.4mm), Thursday Island, no.145, 2-8m, sand, Aug.1881, Dr R.Coppinger HMS *Alert*; BM 1882:7 ♀ (9.3mm), Thursday Island, no.175, 2-8m, sand, Aug.1881, Dr R.Coppinger HMS *Alert*; BM 1882:7 ♀ (5.0mm), Prince of Wales Channel, no.157, 18m, sand, Sept.1881, Dr R.Coppinger HMS *Alert*; AM P36796 ♂ (8.5mm) and P36797 damaged (juv.), Torres Strait, Arafura Sea, stn 1, 10°38'S, 141°6.5'E, 0645-0710 hrs, water temp. 28°C, 5m otter trawl, wire out 150m, time at depth 10mins, depth 25m, 16/3/1975, E.Ball Alpha Helix Exped; QM W10544 ♂ (9.4mm), Torres Strait, 10°02'S, 142°31'E, Torres Strait Prawn Survey stn 300, 13m, 21/4/1974, Qld.Fisheries; QM W10546 ♂ (8.0mm), Torres Strait, 10°02'S, 142°35'E, Torres Strait Prawn Survey stn 298, 15m, sand and shell, 21/4/1974, Qld. Fisheries; QM W10523 ♀ (8.4mm), Torres Strait, 10°2'15"S, 142°36'50"E, Torres Strait Prawn Survey stn 29, sand, 24/3/1974, Qld.Fisheries; QM W10529 ♂ (7.7mm), Torres Strait, 10°12'30"S, 142°41'30"E, Torres Strait Prawn Survey stn 383, 18m, shelly, 2/5/1974, Qld. Fisheries; QM W10530 ♂ (11.9mm), Torres Strait, Torres Strait Prawn Survey stn six 9 NCD, 18-27m, 28/8/1974, Qld.Fisheries; QM W10550 ♀ (10.0mm), Torres Strait, 9°45'S, 143°27'E, stn 17, trawled, 30m, 17/9/1988, I.Poiner R.V.*Kulasi* CSIRO; BM 1970:121 ♂ (6.7mm), 1/2 mile SE of Lizard Is., off Lookout Point, stn xiv, 35m, 7/3/1929, Great Barrier Reef Exped, 1928-29; BM 1970:122 ♂ (5.9mm), in lee of Turtle Isles, off Lookout Point, 15m, 12/3/1929, Great Barrier Reef Exped. 1928-29; QM W9930 ♀ (10.0mm), 15 miles east of Hinchinbrook Is., 18°17'S, 146°31'E, BSQ stn 131, coral rubble, 31m, 17/10/1979, Qld. Fisheries; QM W10549 ♂ (8.9mm), 2♀ (4.3-4.8mm), Abbot Point north of Bowen, N Qld., James Cook Uni; AM P18067 2♂ (5.4-7.0mm), ♀ (6.7mm), off North Keppel Is., N Qld., 51m, Aug.1970, T.Nielsen. (This lot also contains two undetermined juvenile 3.0mm specimens). AM P20006 ♂ (6.6mm), ♀ (6.3mm), South Keppel Is., N Qld., 9-15m, Sept.1970, N.Coleman; QM G14/289 ♂ (15.0mm), Moreton Bay, SEQ, J.Palmer; QM W2942 2♂ (4.7-5.3mm) and W2946 ♀ (5.2mm), Moreton Bay, 3/4 mile NW of M1 red buoy, stn 271, 27°10'50"S, 153°18'20"E, sand and broken shell, 14m, 29/8/1967, W.Stephenson; QM W7406 ♀ (10.9mm), Cowan Cowan, Moreton Bay, SEQ, J.Palmer; QM W10500 6♂ (7.3-8.9mm), 2♀ (5.9mm), channel near Dring Banks, SW of Tangalooma, Moreton Bay, SEQ, clean sand, 14-15m, 15/11/1981, R.Willan; QM W10527 ♂ (8.2mm), south end of Dring Banks, Moreton Bay, SEQ, stn 156, dredged, sand, 29/4/1964, W.Stephenson; QM W10538 ♀ (7.3mm), 1/4 mile south of Dring Banks, Moreton Bay, SEQ, dredged, 18m, 29/4/1964, W.Stephenson; QM

W11363 (7.8mm), Middle Banks, Moreton Bay, SEQ, stn 24, 11.5m, clean sand, June 1973, S. Cook and S. Newlands.

DESCRIPTION

Chelae. Hand of left cheliped with a row of six or seven spines on upper inner border, larger proximally. Outer surface strongly convex and scutellated, each scute with a fringe of plumose setae on the distal edge. Lower scutes have a more convex distal border and are half or less the length of upper scutes. Upper scutes with 1-6 large white tubercles along their length, lower with one or none. Rudimentary tubercles also present particularly on upper scutes. On small specimens the large tubercles are smaller and less numerous and the rudimentary tubercles absent. Inner surface of hand with a few weak scales, some with bristles at their distal edge. Lower border with two rows of tubercles, more obvious in larger specimens, with a few bristles between the tubercles especially distally. When viewed from the inner side the lower border consists of rounded tubercles that do not carry spines. The exterior view shows the lower border as a row of scutes with large tubercles on their lower border. The fingers have much smaller scutes, with tubercles about the same size as those on the hand. Carpus of left cheliped with a row of spines on upper border, increasing in size distally. Smaller spines are present on upper half of outer surface being replaced by spiny scutes on lower half.

Merus of left cheliped triangular in section with small spines on outer distal edge and outer lower distal corner. Inner lower border is a crest divided into seven large rounded teeth, all about equal size.

Right cheliped with tufts of long bristles on the external surface, those on upper half arising from the base of spines. Upper surface of dactylus is spinous. Upper surface of carpus with a bare, oval area surrounded by 7-8 spines. There is no trace of scutes on right cheliped.

Third left leg. Dactylus slightly curved and longer than propodus. Inner surface convex with a longitudinal, median groove which has a row of bristles on the distal third. Inner lower border with a row of small sharp spines on proximal half; upper border spinous with bristles. Outer surface of dactylus flattened with a longitudinal median groove either side of which are transverse scutes. Scutes on upper side of the median groove have small tubercles on their distal edge and spines where they form the border of the dactylus. Scutes on lower side have one large tubercle near border of dactylus and a few much smaller ones towards the groove. Distal edge of scutes is fringed with

plumose setae which become longer towards edges of dactylus where they mix with tufts of long bristles.

Propodus almost naked on inner surface, lower border notched due to scutes on outer surface being truncated at lower margin. The end of each scute carries a tuft of bristles and a spine. Outer surface convex with two rows of scutes either side of a bare median area. Scutes on upper row have small tubercles, those on lower row have larger tubercles with the tubercle near the edge of propodus very much larger. Tubercles are not well developed on smaller specimens and almost non-existent on the very small. Both edges of propodus have long bristles and plumose setae.

Carpus with 2-3 strong spines on upper border; outer distal edge serrated. Inner surface flat, outer surface strongly convex. All surfaces smooth with very few tufts of bristles.

Merus has outer surface convex and inner surface flat. There are 2-3 spines half way along lower inner border. All surfaces smooth with very few tufts of bristles.

Fourth left leg. Carpus has two large and 2-3 small spines on upper surface.

Eye-stalks. Eye-stalks shorter than antennular peduncles, eye occupies more than one-third of eye-stalk. Ophthalmic scales broad, well separated at their bases and have three sharp spines on their anterior margins.

Colouration. Colours given are of preserved specimens. Most colours persist for 10-12 years. Body white to greyish cream. Except for the outer surface of dactylus of the third left leg, dactyli of legs are scarlet to brick red with cream blotches at the base of the tufts of bristles. Scutes on lower half of hand including immovable finger and lower part of movable finger are scarlet to brick red. This colouration ends abruptly where the hand is most convex (at about half the height of the hand). Tubercles on the scutes are white. Upper surface of carpus of both chelipeds bluish grey. Scutes on outer surface of dactylus of third left leg also scarlet to brick red and the tubercles white. Only scutes on the lower half of the propodus of the third left leg are pigmented; sometimes only the distal edge is coloured. The colouration being the same as for the dactylus. Eye-stalks purple for their proximal one third then a band of brown which fades distally to base of eyes.

REMARKS

Because of the similarity of the species involved and the brief description given by Milne Edwards, examination of the holotype of *D. imbricatus* was

considered necessary. Dr J. Forest (MNHN) however has failed to locate the type and it must therefore be presumed lost. He agreed that the erection of a neotype was necessary.

While both *D. squarrosus* sp. nov. and *D. callichela* sp. nov. also fit Milne Edwards' description of the left cheliped and the third left leg only *D. squarrosus* sp. nov. and the present specimens approximate to his vague description of the colour . . . 'Colour whitish mixed with pale red.' The collecting location of Milne Edwards' specimen, Raffles Bay (Northern Territory, Australia), is well within the geographic range of the present specimens while the only known location for *D. squarrosus* sp. nov. is almost 700km further south and 1000km further west. As previous workers have referred to some of the present specimens as *D. imbricatus*, and because of the above facts a neotype was selected from the present specimens following the rules of the I.C.Z.N. The new type locality (Casuarina Beach, Darwin) is about 210 kilometers south-west of the previous type locality (Raffles Bay).

Miers (1876), while not having any specimens, recorded this species from New Zealand. Presumably he thought Raffles Bay to be in that country. His mistake led subsequent workers to include New Zealand when giving the distribution of *D. imbricatus* even though the mistake was pointed out by both Hutton (1882) and Filhol (1886). Miers also states 'There are two specimens from Shark's Bay, W. Australia, which probably belong to this species, in the collection of the British Museum.' Unfortunately these specimens can no longer be located. However as some of the present specimens come from the same area it is not unreasonable to assume that Miers' specimens were *D. imbricatus*. This assumption is supported by the fact that Miers (1884) recorded three specimens from Torres Strait (BM 1882:7). These have been examined and are *D. imbricatus*. He commented on the variation of the tubercles on the scutes of the left cheliped suggesting that the tubercles develop and increase in size as the animal becomes larger. The present material supports Miers' observations, however there is also considerable variation between larger specimens as shown in Figure 2.

Henderson (1888) records *D. imbricatus* from Flinders Passage, Torres Strait. Although his specimens cannot be located his notes are precise enough to confirm his identification. Ortmann (1894) also records *D. imbricatus* from Torres Strait; however, as his material could not be located, the true identity of his specimens must remain in doubt. McNeill (1968) records two

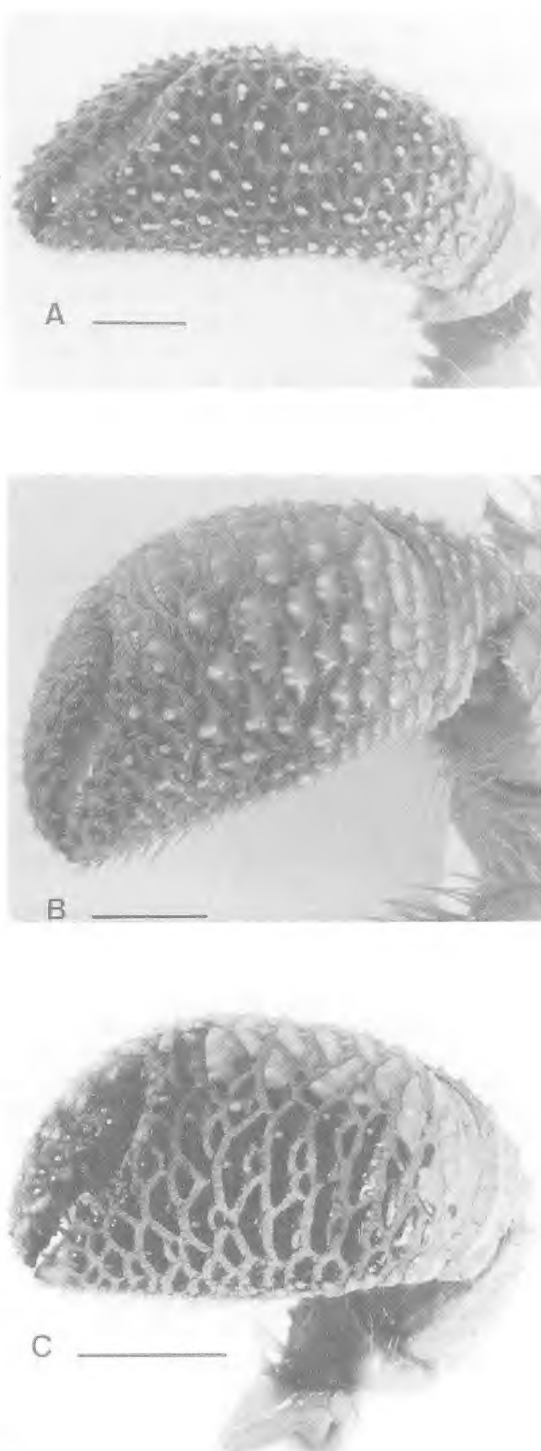


FIG. 2. Outer surface of left cheliped. *Dardanus imbricatus* (H. Milne-Edwards), A. Neotype, ♀ (11.6mm), NTM Cr.3444; B. ♂ (11.9mm), QM W10530; C. ovig ♀ (8.9mm), QM W10545. (Scale = 5.0mm).

specimens from Lizard Island (BM 1970:121, 1970:122) both have been examined and belong to the present species. Haig and Ball (1988) correctly record two specimens from Torres Strait (AM P36796-7). They mention the presence of anemones on the shell of one specimen and give colour notes. Few shells have been kept with the present specimens but most carry at least one anemone. Twelve species of shells are represented suggesting little if any preference for particular shells.

DISTRIBUTION

Northern half of Australia from Shark Bay (W. Australia) in the west to Moreton Bay (Queensland) in the east.

Depth Range: 6-54 m.

Dardanus callichela sp. nov. (Figs 3, 6B, 8A)

Pagurus imbricatus: Alcock, 1905, p. 92, pl. 9, fig. 8; Fize and Serène, 1955, p. 220, fig. 35 A-C, pl. 6, figs. 11-14.

?*Dardanus imbricatus*: Khan and Natarajan, 1984, p. 11, fig. 8.

MATERIAL EXAMINED

HOLOTYPE: QM W10520 ♀ (14.7 mm), NW Shelf, 20°25.4'S, 116°02.6'E, stn 48, 38 m, 14/10/1983, I. Poiner CSIRO.

PARATYPES: MNHN Pg. 2271 ♂ (19.6 mm), Cape St Mary, 17°13'11"N, 107°41'08"E, stn 45, trawl 43, grey mud, 73 m, 12/9/1963, Fish. Research Stn. Hong Kong; NTM Cr. 4187 ♂ (7.5 mm), NW Shelf, 20°01.4'S, 116°57.5'E, 52 m, 22/2/1983, T. Ward R.V. *Soela* CSIRO; WAM 1068-86 ♀ (9.0 mm), NW Shelf, 20°3.7'S, 116°13'E, stn 45, 37 m, 14/10/1983, I. Poiner CSIRO; QM W10518 ♀ (8.3 mm), NW Shelf, 19°45.8'S, 117°52.1'E, 52 m, 2/9/1983, T. Ward R.V. *Soela* CSIRO; QM W10521 ♂ (13.0 mm), NW Shelf, 19°35.8'S, 117°45.9'E, 60 m, 12/10/1983, I. Poiner CSIRO; QM W10522 ♂ (14.9 mm), Chesterfield Reefs, Coral Sea, 19°15.00'S, 158°34.00'E, stn DW 68, 65 m, 24/7/1988, P. Davie R.V. *Coriolis*; MNHN Pg. 4447 ♀ (12.8 mm), Chesterfield Reefs, Coral Sea, 20°28.02'S, 160°56.34'E, stn DW 28, 78 m, 22/7/1988, P. Davie R.V. *Coriolis*.

OTHER MATERIAL: MNHN Pg. 1266-7 2 ♂ (15.0-20.0 mm), Gulf of Siam, 8/12/1927, A. Krempf; MNHN Pg. 2323 ♀ (10.0 mm), Cr 4/63, sta. 2, T/17. [no other data]; NTM Cr. 6582 ♂ (11.5 mm), 18°07.1'S, 118°13.7'E, stn T/28/62, 350 m, 2/2/1984, R.V. *Soela* CSIRO; QM W10537 ♂ (8.1 mm), NW Shelf, 18°56.9'S, 118°45.2'E, 86-88 m, 7/12/1982, T. Ward R.V. *Soela* CSIRO.

DESCRIPTION

Chelae. Hand of left cheliped with a row of six or seven spines on the upper inner border. Outer

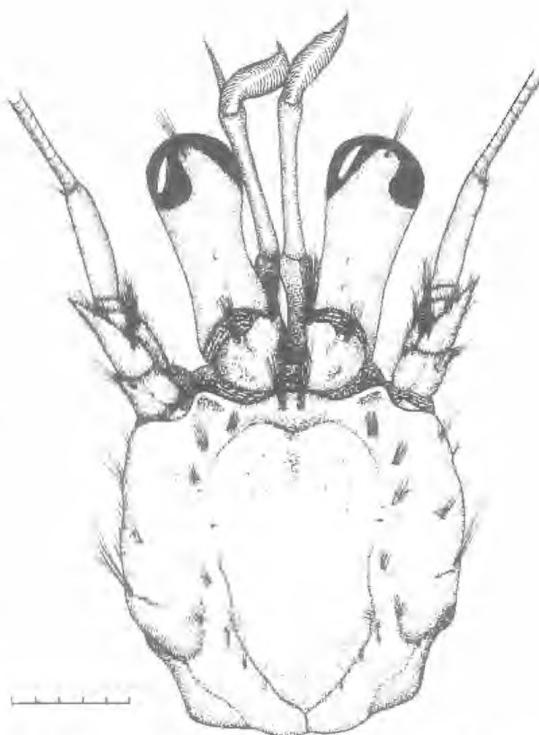


FIG. 3. *Dardanus callichela* sp. nov. Shield and cephalic appendages. Holotype, ♀ (14.7 mm), QM W10520. (Scale = 5.0 mm).

surface strongly convex and scutellated with a fringe of plumose setae on the distal edge of each scute. Scutes on unworn specimens have from 0-5 small sharp spines on the anterior edge. There is no relationship between scute size and number of spines. Inner surface of hand with a few weak scales some with bristles at their distal edge. Lower border with long plumose setae which form a thick brush. When viewed from the inner side the lower border consists of robust multidentate spines. The exterior view shows fine outwardly directed spines protruding through plumose setae. Spines arise from the distal edge of scutes along the lower border however these scutes are mostly hidden by plumose setae. Fingers also scutellated, with spinous scutes at lower border of immovable finger and upper border of dactylus.

Carpus of left cheliped with a row of spines on upper border, increasing in size distally. Smaller spines are present on upper half of outer surface being replaced by spiny scutes on lower half.

Merus of left cheliped triangular in section with spines on outer distal edge and outer lower distal corner. Lower third of outer surface scutellated. Inner lower border is a crest divided into seven acute teeth of about equal size.

Dactylus and propodus of right cheliped covered with tufts of long bristles. Four rows of spines run along dorsal surface of the dactylus; propodus with spinous upper half. Upper surface of carpus with a bare, flat, oval area surrounded by seven large spines. There are no scutes on the right cheliped, although the bases of the tufts of bristles give a scutellated appearance.

Third left leg. Bordered by a dense brush of long bristles and plumose setae, the dactylus longer than propodus. Inner surface of dactylus with a longitudinal, median row of stiff bristles on distal quarter. Small patches of bristles are scattered over the rest of the surface, upper proximal ones having spinous bases. Upper border with a row of long sharp spines just inside the brush of setae. Proximal half of lower border with a row of spines decreasing in size distally. Outer surface of dactylus flattened with a smooth, longitudinal, median area, ill-defined in larger specimens, either side of which are transverse scutes. Distal edge of each scute fringed with plumose setae becoming longer towards edges of the dactylus where there are also long bristles. Scutes have 1-2 spines where they meet the edge of the dactylus.

Propodus with a row of large spines, single and multidentate, along the lower inner edge and except for a few spines on the upper part the rest of the inner surface is almost naked. Outer surface convex with two rows of scutes. Scutes have spines where they form the edge of the propodus.

Carpus scutellated on outer surface. Scutes are spinous with the fringe of plumose setae becoming longer towards edges of carpus. Outer distal edge of carpus with a large scute, the distal edge of which is spinous and fringed with long plumose setae. Upper surface with tufts of long plumose setae and bristles intermixed with spines at the distal edge. Inner surface smooth, slightly convex with three large spines on lower distal border and two large and one small spine on upper distal border.

Outer surface of merus weakly scutellated on lower distal half. Scutes spinous with long plumose setae where they form the distal edge. Lower edge has long bristles with 3-4 strong teeth.

Fourth left leg. Carpus with 6-7 long, sharp, curved spines on upper surface.

Eye-stalks. Eye-stalks shorter than antennular peduncles, eye occupies more than one third of eye-stalk. Ophthalmic scales broad, well separated at their bases and have three large spines on their anterior margin, just posterior is a row of bristles.

Colouration. Colours are for recently preserved specimens (since 1982). Body cream with a scat-

tering of tiny scarlet dots on all calcified areas including telson. Dactylus of walking legs orange to brick red, with cream blotches at base of tufts of bristles. Distal half of fingers on right cheliped similarly coloured. Scutes on fingers and hand of left cheliped pink bordered by scarlet, some with a lilac hue. The colour is most brilliant on lower part of hand and immovable finger. Where the hand is most convex colour fades and scutes above this area have very little colouration. Scutes on outer surface of dactylus and propodus of third left leg are similar to those on lower part of hand. Proximal half of eye-stalks royal purple.

REMARKS

Both Alcock (1905) and Fize and Serène (1955) have illustrated and commented on this species believing their specimens to be *D. imbricatus*. This is no doubt due to Milne Edwards' (1848) inadequate description, and the fact that this species has 'imbricate scales' on the left cheliped.

Alcock's (1905) description (including colouration) and figure are precise enough to place his specimen in this species. The only point of disagreement between his description and the present specimens being the outer surface of the carpus of the left cheliped. Alcock's specimen differs in that '... its carpus has the upper (inner) border spinose, and all the outer surface covered with imbricating squamiform tubercles, ...' although his illustration shows no such sculptures. On the present specimens the ornamentation is only on the lower half and weakly represented. Alcock also points out the difference between this specimen and *Pagurus striatus* (< *Dardanus arrosor*) a species with squamiform markings on both left and right chelae and legs.

Fize and Serène repeat Alcock's description and use it for the basis of their identifications. They give the colouration of their specimens with which the present specimens agree. They also comment on observations made by Miers (1884) and Henderson (1888) regarding tubercles on the left cheliped (see *D. imbricatus*) pointing out that their (Fize and Serène) specimens do not have any such tubercles. They further suggest that the specimens of Miers and Henderson '... possibly belong to a different species (*P. pectinatus*)'. Fize and Serène say they accept Alcock's separation of *P. imbricatus* from *P. arrosor* but express doubt about the significance of the scales on legs 1-3 on the right side in *P. arrosor* and give a lengthy comparison between *P. imbricatus*, *P. arrosor*, *P. pectinatus* and *P. insignis*, the latter 3 species having been discussed in some detail by Schmitt (1926). As *P.*

pectinatus and *P. insignis* are Atlantic species Fize and Serène's comparison seems irrelevant. The figure by Fize and Serène leaves no doubt that their specimens belong to the present species.

Ajmal Khan and Natarajan (1984) give little to help with the identity of their specimen. Their brief colour notes together with the locality of their specimen (Bay of Bengal) suggest that their specimen may belong to the present species. Their figure is not detailed enough to be of any assistance.

ETYMOLOGY

The specific name refers to the colouring of the left cheliped, and is from the greek *callos* (beautiful) and *chele* (claw).

DISTRIBUTION

Sri Lanka, South China Sea, NW Australia and Chesterfield Reefs.

DEPTH RANGE

37-88m. The depth of 350m recorded for NTM Cr.6582 is in some doubt as the locality data for this specimen was queried on the specimen label, and it is substantially deeper than all other records.

Dardanus corrugatus sp. nov.

(Figs 4, 6C, 8B)

MATERIAL EXAMINED

HOLOTYPE: NTM Cr.3665 ♂ (12.8mm), Observation Point, Port Essington, 11°16.8'S, 132°10.5'E, stn CP-59, rocky reef, 15/3/1983.

DESCRIPTION

Chelae. Hand of left cheliped with a row of seven spines on upper inner border, larger proximally. Outer surface embossed by more or less vertical ridges finely granular on their distal edge. The ridges vary in length and are shorter, wider and more scale-like on the fingers. Plumose setae, approximately as long as the ridges are wide, originate from under the granules forming a fringe and giving a somewhat banded effect. The ridges are truncated on the sinuous lower margin giving a palisade effect. This can only be seen from the inner side as the outer side is hidden by a row of tufts of bristles which run along the distal three-quarters of lower margin. The end of each ridge on distal two-thirds of lower margin bears 2-3 spines. Dactylus of left cheliped with a row of tubercles, becoming spinous distally, along the dorsal edge. Inner surface of hand has some weakly formed tubercles with bristles on their

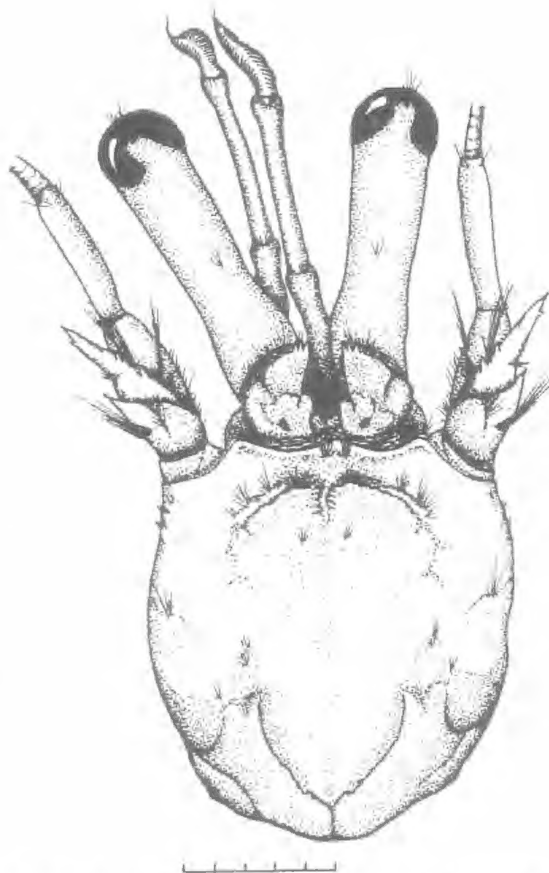


FIG. 4. *D. corrugatus* sp. nov. Shield and cephalic appendages. Holotype, ♂ (12.8mm), NTM Cr.3665. (Scale = 5.0mm).

distal edge, and a few very weakly formed tubercles posterior to the immovable finger.

Upper surface of carpus of hand with a bare, flat, oval area surrounded by 7 large spines. Outer lower surface slightly scutellated, inner surface smooth with strong tooth on lower edge.

Merus of left cheliped triangular in section with three spines on outer upper edge and two at lower distal corner. Inner lower border is a crest divided into seven large rounded teeth, larger proximally.

Right cheliped with tufts of long bristles on dactylus and propodus. Two rows of spines run along the dorsal surface of the dactylus and propodus. Carpus with a flat, bare, oval area surrounded by seven large spines. Propodus also with a bare, flat area on upper proximal surface. There is no trace of scutes on the right cheliped.

Third left leg. Dactylus strongly curved and longer than propodus. If a chord is drawn the

greatest distance between it and the dactylus approximates to the height of the dactylus at that point. Inner surface convex with a shallow longitudinal groove which has a row of stiff bristles along the ventral edge. Lower inner border with a row of equally spaced tufts of bristles; upper inner border more or less covered by tufts of bristles. Outer surface of dactylus flattened with a faint, longitudinal, median groove which bears some small, transverse scutes and has tufts of bristles along both edges. Either side of the longitudinal groove are scutes whose distal edge has a fringe of plumose setae and a hint of granulation.

Propodus almost naked on inner surface while outer surface is slightly convex with two rows of scutes similar to those on the dactylus.

Carpus with two strong spines on upper distal border; outer distal edge serrated. Both carpus and merus have their inner surface flat and outer surface convex, all are smooth with very few tufts of bristles.

Merus with three spines half way along the inner lower border.

Fourth left leg. Carpus of left leg with one spine on the upper surface.

Eye-stalks. Eye-stalks only just shorter than antennular peduncles; eye occupies about one quarter of eye-stalk. Ophthalmic scales broad with sharp spines on their anterior margin.

Colouration. Body cream, scutes on left cheliped and outer surface of third left leg maroon. Tips of larger granules on these scutes white. Upper surfaces of carpus of both chelipeds iridescent blue-grey. Patches of blue-grey and maroon together with cream give a mottled effect on the inner surface of propodus, carpus and merus of both chelipeds. Walking legs similarly coloured, and in addition having a maroon band on each propodus and a slightly lighter band on each carpus and merus. Ophthalmic scales and front region of carapace have traces of lavender. Eye-stalks lavender with pale orange on their bases and midway along their length.

ETYMOLOGY

The specific name refers to the sculpturing on the left cheliped, and is latin for ridged or wrinkled.

DISTRIBUTION

Known only from the type locality.

***Dardanus squarrosus* sp. nov.**
(Figs 5,6D,8C)

Pagurus imbricatus: Balss, 1921, p.21.

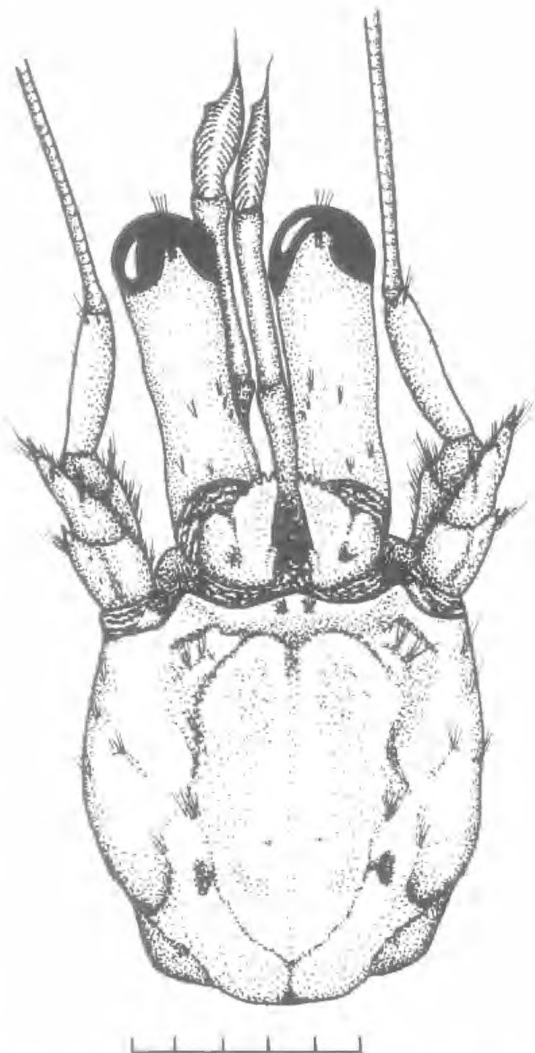


FIG. 5. *D. squarrosus* sp. nov. Shield and cephalic appendages. Holotype, ♂ (9.4mm), NRS 11003. (Scale = 5.0mm).

MATERIAL EXAMINED

HOLOTYPE: NRS 11003 ♂ (9.4mm), Cape Jaubert, NW Australia, 45 miles WSW, 18m, 14/7/1911, E.Mjoberg.

PARATYPE: WAM 1067-86 ♂ (10.2mm), no data available. (Presumably W. Aust.).

DESCRIPTION

Chelae. Hand of left cheliped with a row of seven spines on upper inner border. Entire outer surface covered with scutes of various sizes. Distal edge of most scutes convex to varying degrees and fringed with plumose setae. Scutes have 0-3 rounded tubercles towards their distal edge. Scutes at the lower border are truncated giving a palisade

effect on the inner side; on the distal two-thirds truncated ends of scutes have 2-3 spines. Dactylus of left cheliped with scutes similar to those on the hand and with spinous tubercles on the dorsal edge. Inner surface of hand has weak tubercles with bristles on their distal edge.

Carpus of left cheliped with a bare, flat, oval area surrounded by seven large spines on upper surface. Outer surface with traces of scutes; inner surface smooth with a strong tooth on lower edge.

Merus of left cheliped triangular in section with three spines on outer upper edge and three at lower distal corner. Inner lower border is a crest divided into eight large rounded teeth, the largest proximal.

Right cheliped with tufts of long bristles on dactylus and propodus; dorsal surface of both spinous. Carpus with a flat, bare, oval area, surrounded by seven large spines. Propodus also with a bare, flat area on upper proximal surface. There is no trace of scutes on the right cheliped.

Third left leg. Dactylus curved and longer than propodus. Inner surface of dactylus convex with a shallow longitudinal groove along which there are tufts of bristles. Lower border finely serrate on proximal one third. Upper inner border spinous with long bristles. Outer surface flattened; upper half excavated especially proximally. Both upper and lower halves with a row of transverse scutes whose distal edge has a fringe of plumose setae becoming longer towards edges of the dactylus. Distal edge of scutes on lower half weakly tubercular with tubercles becoming much larger towards the lower border where some are spinous. Distal edge of scutes on upper half smooth with large slender spines on upper border.

Propodus almost naked on inner surface; lower border notched, due to truncation of scutes on the outer surface, the end of each scute has a large spine and a tuft of bristles. Outer surface with a very convex, smooth area, with transverse scutes either side. Distal edge of these scutes is fringed with plumose setae, becoming longer towards the edges of propodus, and weakly tubercular, tubercles increasing in size towards both edges of propodus where they become spinous.

Carpus with two large spines on upper distal border; outer distal edge consists of multidentate spines. Lower distal margin with three weak, transverse, spinous ridges. Both carpus and merus with inner surfaces flat and outer surfaces convex, all are smooth with very few bristles. Merus with a medial spine on lower inner border.

Fourth left leg. Carpus with one spine on upper surface.

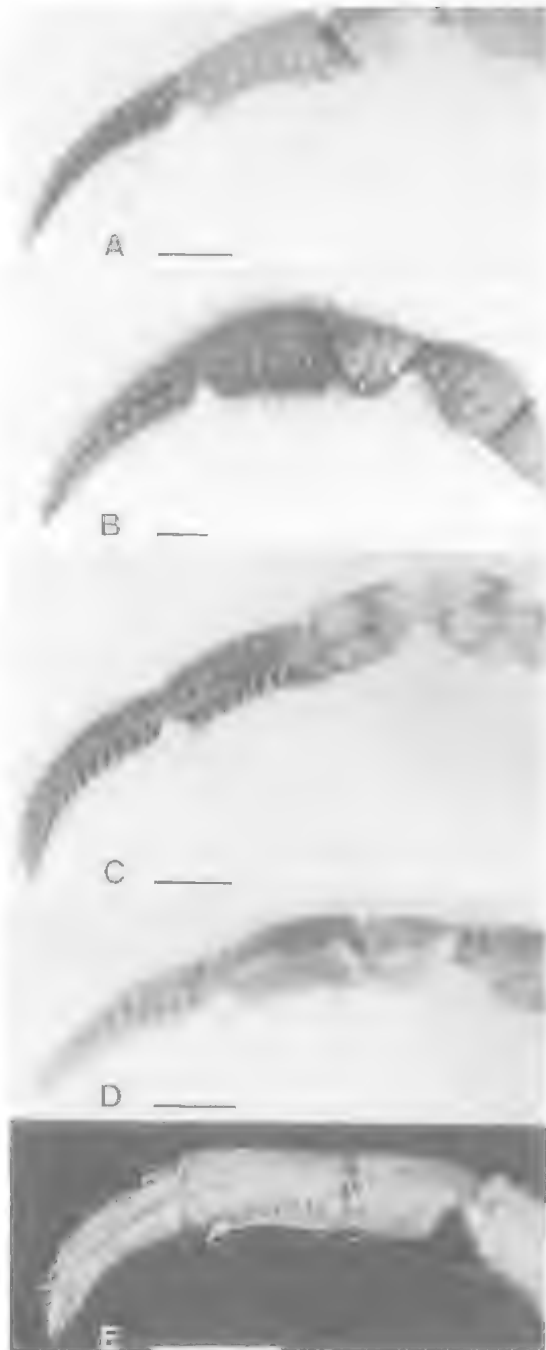


FIG. 6. Outer surface of third left leg. A. *Dardanus imbricatus* (H.Milne-Edwards), neotype, ♀ (11.6mm), NTM Cr.3444; B. *D. callichela* sp. nov., holotype, ♀ (14.7mm), QM W10520; C. *D. corrugatus* sp. nov., holotype, ♂ (12.8mm), NTM Cr.3665; D. *D. squarrosus* sp. nov., holotype, ♂ (9.4mm), NRS 11003; E. *D. undulatus* (Balss), holotype, ♀ (8.3mm), NRS Type No.3115. (Scale = 5.0mm).

Eye-stalks. Eye-stalks just shorter than antennular peduncles, eye occupies about one quarter of eye-stalk. Ophthalmic scales broad with three large spines on anterior margin.

Colouration. Colours are of the preserved paratype, the holotype while still showing colour patterns has faded to a greater degree. Body cream, scutes on left cheliped and outer surfaces of third left leg brick-red. Tips of larger tubercles on these scutes white. Upper surface of carpus of both chelipeds slightly iridescent. Inner surface of propodus, carpus and merus of both chelipeds with patches of brick-red giving a mottled appearance. Walking legs with a brick-red band on propodus, carpus and merus, dactyli mottled brick-red and cream. Eye-stalks with a feint orange band just over half way along length.

ETYMOLOGY

The specific name refers to the sculpturing on the left cheliped, and is latin for rough with scales.

DISTRIBUTION

The only known locality is Cape Jaubert (W.Australia).

Dardanus undulatus (Balss, 1921) (Figs 6E, 7.8D)

Pagurus undulatus Balss, 1921, p. 20, fig. 12.

MATERIAL EXAMINED

HOLOTYPE: NRS Type No.3115 ♀ (8.3mm), Cape Jaubert, NW Australia, 45 miles WSW, 18-22m, -7/1911, E.Mjöberg.

DESCRIPTION

Chelae. Hand of left cheliped with a row of seven spines on upper border, larger proximally. Outer surface strongly convex and embossed with more or less vertical, granulated ridges of varying length. The diameter of the granules approximates to the width of the ridges as does the fringe of plumose setae that originates from the distal edge of each ridge. Ridges on dactylus and immovable finger also granular but much shorter and slightly wider than on hand. A group of six short spines is present just posterior to tip of the dactylus. Lower part of hand posterior to the immovable finger with a depressed area which makes the lower margin cristate. Viewed externally the lower border is fringed with very long plumose setae. Inner view shows a palisade effect formed by ridges on the outer surface being truncated at the lower margin. The end of each ridge has three short, robust spines and a tuft of very long

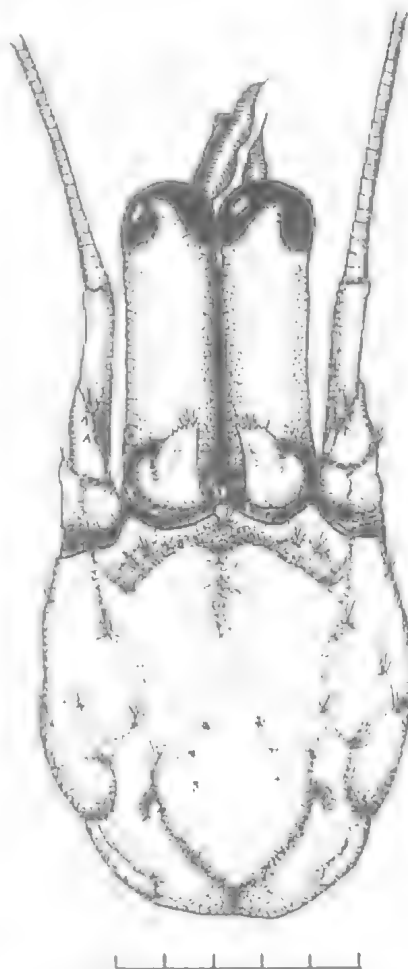


FIG. 7. *D. undulatus* (Balss). Shield and cephalic appendages. Holotype, ♀ (8.3mm), NRS Type No.3115. (Scale = 5.0mm).

plumose setae. Inner surface of hand with only a few weak tubercles.

Carpus of left cheliped with a flat, bare, oval area surrounded by eight large spines on upper surface. Outer surface with a few spines that give way to granules on the lower part.

Merus triangular in section with two spines at outer distal edge and two at lower distal corner. Inner lower border is a crest divided into three areas by fissures; the proximal area having two rounded teeth, the middle area a single rounded tooth and the distal area four sharp spines.

Right cheliped with tufts of long bristles; upper surface of dactylus and propodus spinous. Upper surface of carpus with a bare, flat, oval area similar to the carpus of the left cheliped.

Third left leg. Dactylus longer than propodus; both thickly fringed with very long plumose setae on outer surface. Inner lower border fringed by bristles; inner upper border has tufts of bristles with spines at their bases. Outer surface flattened with a deep median groove; either side are transverse granular scutes whose distal edge is thickly fringed by long plumose setae becoming much longer towards edges of the dactylus.

Outer surface of propodus with a median ridge; the area above the ridge excavated. Either side of the ridge are transverse granulated scutes fringed with plumose setae. The setae are about as long as the scutes are wide, becoming longer towards the edges of the propodus. The granular scutes on the lower part of propodus extend up on to the median ridge where the granules become larger giving the ridge a granular appearance. Inner surface of propodus smooth, convex and with a row of evenly spaced tufts of bristles along the lower border.

Carpus and merus with smooth, convex inner

and outer surfaces. Carpus with two spines on upper distal edge; outer distal edge granulated and fringed with plumose setae. Merus with two spines on lower inner border.

Eye-stalks. Eye-stalks about as long as antennular peduncles, eye occupies less than one quarter of eye-stalk. Anterior border of ophthalmic scales with five spines decreasing in size laterally.

Colouration. The specimen has lost all trace of colour. Balss (1921) does not mention the colouration of the specimen.

DISTRIBUTION

Known only from the type locality.

DISCUSSION

The degree of sculpturing on the external surface of the left cheliped enables the present group of species to be easily separated from all other Indo-West Pacific species in the genus — with the exception of *D. arrosor*. In other species the

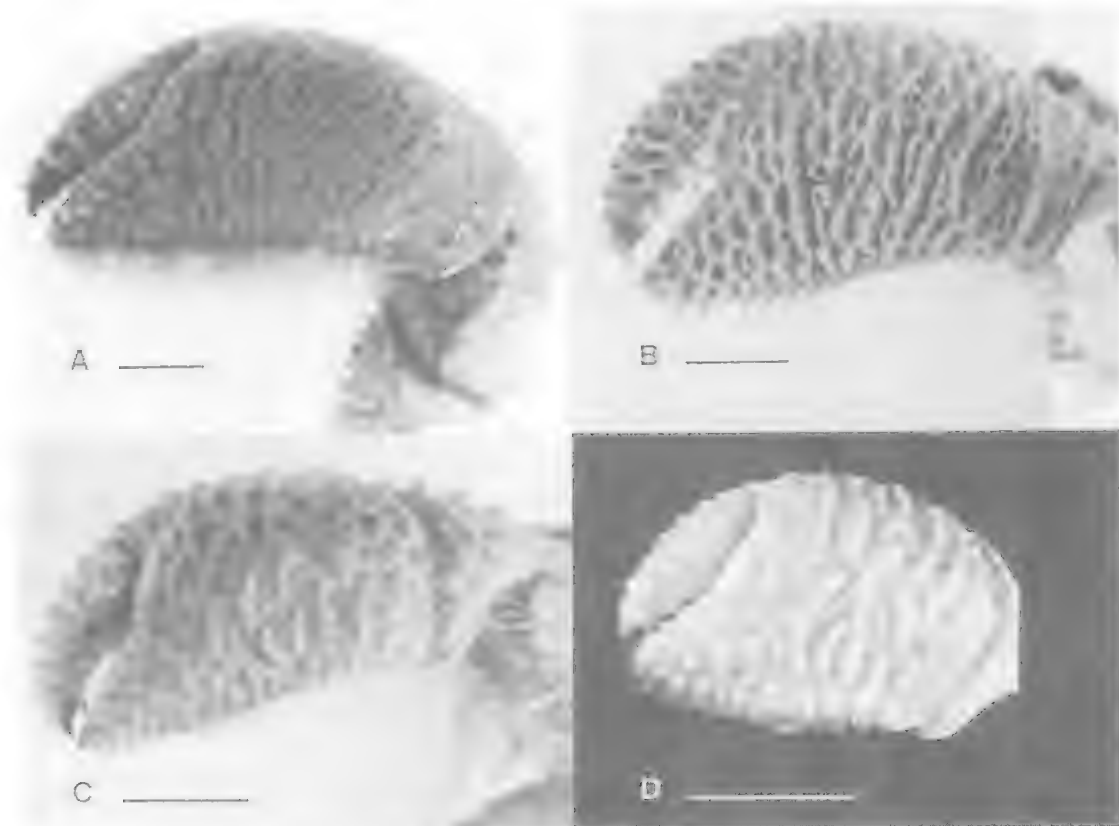


FIG. 8. Outer surface of left cheliped. A. *Dardanus callichela* sp. nov., holotype, ♀ (14.7mm), QM W10520; B. *D. corrugatus* sp. nov., holotype, ♂ (12.8mm), NTM Cr.3665; C. *D. squarrosus* sp. nov., holotype, ♂ (9.4mm), NRS 11003; D. *D. undulatus* (Balss), holotype, ♀ (8.3mm), NRS Type No.3115. (Scale = 5.0mm).

external surface of the left cheliped is either smooth, finely granular or spinous whereas in *D. arrosor* and in the present species it is highly sculptured. As *D. arrosor* has sculpturing on both chelipeds and on all walking legs it is easily separated from all the present species.

Traditionally, species within the genus have been separated into two major groups based on eye-stalk length. Those with short eye-stalks where the cornea occupies a third or more of the eye-stalk and those with long eye-stalks where the cornea occupies a quarter or less of the eye-stalk length. Applying this criterion to the present species-group separates *D. imbricatus* and *D. callichela* sp. nov. with short eye-stalks from *D. corrugatus* sp. nov., *D. squarrosus* sp. nov. and *D. undulatus*.

Dardanus imbricatus is separated from *D. callichela* sp. nov. by the presence of tubercles on the scutes of the left cheliped and by the smooth surface of the outer face of the carpus of the third left leg which is scutellated in *D. callichela* sp. nov. For both species ratios were calculated between length/height of the propodus of the left cheliped; eye-stalk length/cornea diameter and between the dactylus/propodus and propodus/carpus of the third left leg. Ratios for both *D. imbricatus* and *D. callichela* sp. nov. showed considerable variations which could not be related to either size or sex. As some values for both species overlapped these ratios cannot be considered as taxonomically important. In the second group *D. squarrosus* is separated by the presence of scutes on the outer surface of the left cheliped. *Dardanus corrugatus* is separated from *D. undulatus* by the former having the outer surface of the propodus of the third left leg slightly convex where as in *D. undulatus* the propodus has a median ridge with the area above the ridge excavated.

ACKNOWLEDGEMENTS

I wish to thank the following curators and their institutions for the loan of their specimens: Dr J. Lowry — AM; Dr R.W. Ingle — BM; Dr J. Forest — MNHN; Dr Å. Andersson — NRS; Dr A.J. Bruce — NTM; Dr G. Morgan — WAM. Thanks also to Peter Davie for encouragement and advice through the preparation of the manuscript and for reading the final draft. John Short took the photographs which were printed by Gary Cranich. The line drawings were done by Lynn Prior.

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NEW RECORDS OF *DEMANIA* (CRUSTACEA : DECAPODA : XANTHIDAE) FROM AUSTRALIA

P.J.F. DAVIE

Davie, P.J.F. 1989 11 13: New records of *Demania* (Crustacea: Decapoda: Xanthidae) from Australia. *Mem. Qd Mus.* 27(2): 123-128. Brisbane. ISSN 0079-8835.

Three species of *Demania*, *D. splendida* Laurie, 1906, *D. wardi* Garth and Ng, 1985, and *D. cultripes* (Alcock, 1898) are recorded from Australia for the first time. *D. macneilli* Garth, 1976, previously recorded from northern Queensland, is considered a junior synonym of *D. cultripes*. The first male gonopod of *D. wardi* is figured for the first time. *D. splendida* is recorded from the Pacific Ocean for the first time.

□Crustacea, Decapoda, Xanthidae, *Demania*, new records, Australia.

P.J.F. Davie, Queensland Museum, PO Box 300, South Brisbane, Queensland 4101, Australia; 1 December, 1988.

While I was examining the Australian Xanthoidea — a project sponsored by a grant from the Australian Biological Resources Study — a number of specimens of *Demania* were found. Crabs of this genus are known to contain strong toxins and to have caused several deaths in the Philippines (see review by Llewellyn and Davie, 1987). Because only *D. macneilli* Garth, 1976, has been previously recorded from Australia, the present records are noteworthy.

Measurements are of carapace breadth. QM = Queensland Museum, WAM = Western Australia,

NTM = Northern Territory Museum, QFS = Fisheries Research Branch, Department of Primary Industries. Drawings were made with the aid of a drawing tube.

Demania splendida Laurie 1906 (Figs 1, 2, 3a-c)

Demania splendida Laurie, 1906, p. 397, pl. 1, fig. 8, pl. 2, fig. 1; Serène, 1969, pp. 1-2, fig. 1, pl. 1A-E; 1984, p. 190, fig. 109, pl. XXVII; Guinot, 1979, p. 58, fig. 17A, pl. 4, figs 1-3.



FIG. 1. *Demania splendida* (♂, QM W12094). Scale in mm.

MATERIAL EXAMINED

WAM 448-87, 1♀ (33.6mm), NW Cape Inscription, Shark Bay, WA, Honolulu dredge, 40-42 fathoms, sand, Royce on 'Davena', 15.v.1960. WAM 449-87, 1♂ (26.0mm), NW of Dampier, WA, 42-47 fms, trawled C. Ostie, 1978. QM W12140, 1♀ (29.9mm), trawled 'Soela', NW Shelf, NWA, 19°56.8'S, 117°03.5'E, CSIRO, 25.vi.1983. QM W12094, 1♂ (35.6mm), E of Slashers Reefs, Qd, 18°30'S, 147°16'E, trawled 62m, QFS, 8.v.1985.

REMARKS

The specimens examined above are indistinguishable from the descriptions and figures of *D. splendida* provided by other authors except for the form of the tip of the first male gonopod. Both Serène's (1969, 1984) figures show the apex to bear two stiff hairs, a feature unique amongst the *Demania* species. Both males of the present series are similar in bearing 10-12 long feathered hairs, more like other species. This feature in itself did not seem sufficient to warrant giving them specific or subspecific rank particularly when such little material has been studied and given the rather labile state of recent *Demania* taxonomy. The large Queensland male has retained vestiges of the live colour pattern with various sized pink spots on the carapace and dorsal surface of legs and chelae as shown in the accompanying figure.

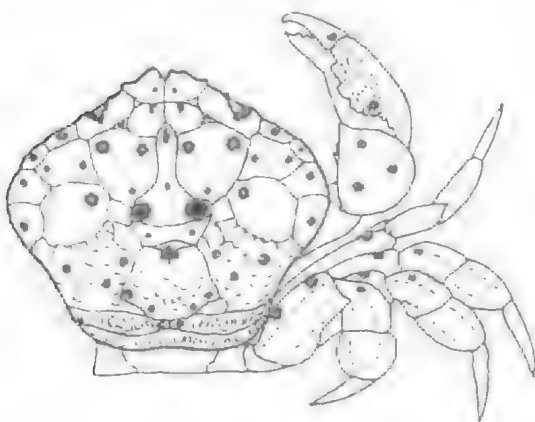


FIG. 2. *Demania splendida* (♂, QM W12094) showing live colour pattern of reddish-pink spots.

DISTRIBUTION

These records considerably extend the known range from Madagascar to Australian east Indian Ocean waters, and to the Pacific in northern Queensland.

HABITAT

The present specimens were all trawled in depths of about 60-90m, one being recorded as coming from a sandy substrate.

***Demania wardi* Garth and Ng, 1985**
(Figs 3d-g, 4)

Demania wardi Garth and Ng, 1985, pp. 294-6, pl. 1A,B, 2A,B.

Demania rotundata: Mallick and Greenbaum, 1975 (not seen, cited in Garth and Ng, 1985).

MATERIAL EXAMINED

QM W12310, 1♂ (39.4mm), trawled R.V. 'Soela', 40 km ENE Britomart Reef, NEQ, 18°07'S, 147°11'E, 200m, 9.xii.1985, P. Davie. QM W12311, 1♂ (48.6mm) 1♀ (45.9mm), trawled R.V. 'Soela', 100 km E of Dunk Island, NEQ, 17°59'S, 147°06'E, 295m, 9.xii.1985, P. Davie. QM W3160, 1♂ (50.7mm), trawled 110m, E of Caloundra, SEQ, April 1969.

REMARKS

The specimens agree in most respects with the description given by Garth and Ng (1985) of the holotype. The posterior and postero-lateral regions can be better described as being covered in rounded tubercles rather than being squamous. The female holotype is a somewhat larger specimen than those in the present collection and it is likely that the posterior tubercles become squamous on large females (as is the case in *D. cultripes*). The basal part of the cutting edges of the chelipeds are cut into distinct teeth in the present specimens. Apparently the straight, untoothed condition of the holotype female is a function of size. The male first pleopod is figured here for the first time. Although it does differ slightly from that figured for *D. rotundata* by Garth and Ng (1985) it is of doubtful use in separating the two species. Only a small twist of the tip of the pleopod would be needed to make it indistinguishable from Garth and Ng's figure of *D. rotundata*. The smaller males first gonopod differs from the larger by having the tip much straighter and not yet sharply curved back on itself.

DISTRIBUTION

Suva, Fiji (Garth and Ng, 1985) and now from off Queensland. It has also been reported from the New Hebrides as a Pleistocene fossil (as *D. rotundata*) in Mallick and Greenbaum (1975).

HABITAT

Appears to be a moderately deep water species (110-400m).

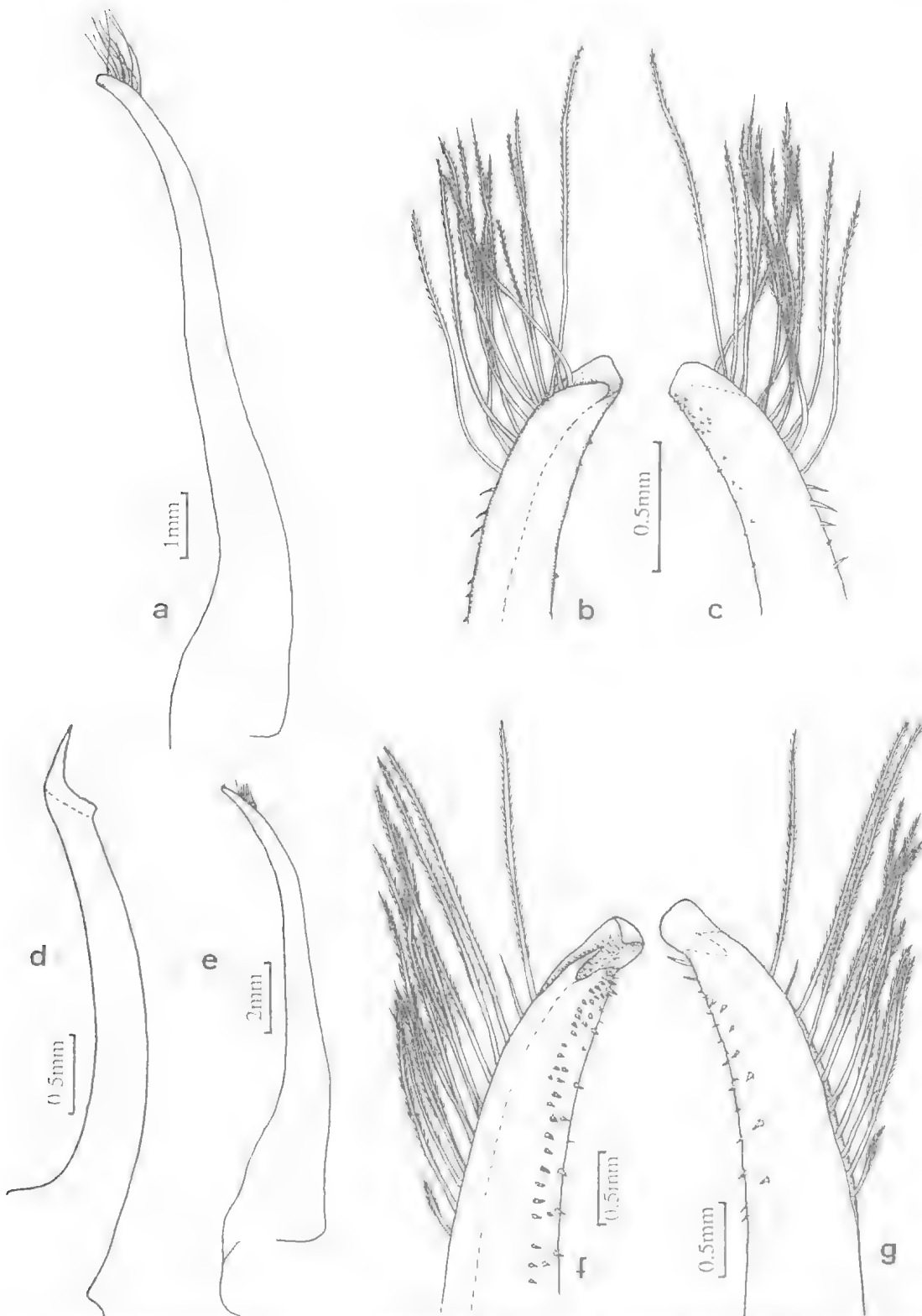


FIG. 3. a-c, *Demania splendida*, first male gonopod (QM W12094), d-g, *Demania wardi* (QM W12311), d, second male gonopod, e-g, first male gonopod.



FIG. 4. *Demania wardi* (♂, QM W14943), showing live colour pattern. Carapace breadth = 55.4mm.

***Demania cultripes* (Alcock, 1898)**
(Fig. 5)

Xantho (Lophoxanthus) scaberrimus var. *cultripes*
Alcock, 1898, p. 117.

Demania scaberrima cultripes: Guinot, 1969, p. 235.

Demania cultripes: Guinot 1979, p. 61, pl. 4, figs 7,8;
Garth and Ng, 1985, pp. 299-302, pl. 4, figs 2A-C,
4.

Demania alcalai Garth, 1975, pp. 2-6, fig. 1.

Demania macneilli Garth, 1976, pp. 113-117, fig. 1A-F.
For full synonymy see Garth and Ng (1985).

MATERIAL EXAMINED

QM W14942, 1♀ (63.6mm), Trawled 'Southern Intruder' inside Swain Reefs, 22°14'S, 152°27'E, 60m, 2.xi.1983, QFS. QM W14943, 1♂ (55.4mm), trawled ENE of Palm Island, 18°38.2'S, 146°51.4'E, 40m, 28.ix.1986, QFS. QM W12312, 1 ovig.♀ (65.0 mm), 90 km E of Lucinda, NEQ, 56m, 16.iv.1985, QFS. QM W12313, 1 juv.♀ (31.2mm), near John Brewer Reef, 18°47'S, 147°03'E, 45m, 21.vii.1985, QFS. QM W12314, 1♂ (56.3mm), Cape Melville, SE of Pipon Island, 18m, 17.ii.1982, QFS. QM W9943, 1♀ (62.2mm), 25 km W Lizard Island, NEQ, 14°38.5'S, 145°13'E, 13.5m, 18.ix.1979, QFS. NTM Cr 3244, 1♂ (52.4mm), Arafura Sea, 10°07.5'S, 136°44.0'E, 51-57m, 17.iii.1985, W. Houston.

REMARKS

When *D. macneilli* was described *D. cultripes* was still poorly known, but since the redescription by Garth and Ng (1985) it is clear that they can no

longer be justifiably separated. *D. macneilli* was said to differ from *D. cultripes* by the degree of prominence of the tubercles at the inner angle of the wrist and near the base of the pollex; and by the raised rows of granules on the dorsal surfaces of the leg joints being obsolete rather than obsolescent. The present specimens show perfect conformity to the chelae characters described and illustrated for *D. cultripes* by Garth and Ng (1985), and the granulation on the legs varies between specimens from obsolete to clearly obvious. The immature female (W12313) is distinctly more coarsely granulate than the other specimens and the male specimens are also more granulate than the females, especially towards the posterior half where the tubercles are more prominent and rounded rather than being squamous as in the females. The male specimen from the Arafura Sea (NTM Cr 3244) is slightly unusual in having the third antero-lateral tooth noticeably upturned rather than projecting flatly. Figure 3 shows the colour pattern which persists as a pinky orange on preserved specimens.

DISTRIBUTION

Singapore (Alcock, 1898; Garth and Ng, 1985), Philippines (Garth, 1975; Garth and Ng, 1985), New Caledonia (Guinot and Richer de Forges, 1981), Arafura Sea, northern Australia, and eastern Australia south to Gladstone (Garth, 1976 and present paper).



FIG. 5. *Demania cultripes* showing live colour pattern (Courtesy Fisheries Research Branch, Department of Primary Industries).

HABITAT

In Australian waters they are normally caught as part of the prawn trawlers 'by-catch' and have been taken in depths from 18 to 60 metres. The holotype female of *D. alcalai* from the Philippines was however found in a bamboo fish trap in only 1m of water.

ACKNOWLEDGEMENTS

The author is grateful to Dr G. Morgan and Dr A.J. Bruce for the loan of specimens from the Western Australian Museum and the Northern Territory Museum respectively, to Dr T. Ward of the CSIRO, and to Messrs C. Jones and K. Derbyshire, of the Fisheries Research Branch, Department of Primary Industries, for donation of specimens. The photograph of *D. cultripes* is reproduced with kind permission of the Fisheries Research Branch. Mr Philip Lawless prepared the figures.

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A RE-APPRAISAL OF *HETEROPANOPE* STIMPSON, AND *PILUMNOPEUS* A. MILNE EDWARDS (CRUSTACEA : DECAPODA : PILUMNIDAE) WITH DESCRIPTIONS OF NEW SPECIES AND NEW GENERA.

P.J.F. DAVIE

Davie, P.J.F. 1989 11 13: A re-appraisal of *Heteropanope* Stimpson, and *Pilumnopus* A. Milne Edwards (Crustacea : Decapoda : Pilumnidae) with descriptions of new species and new genera. *Mem. Qd Mus.* 27(2): 129-156. Brisbane. ISSN 0079-8835.

The type species of *Heteropanope* Stimpson, *H. glabra* Stimpson, and *Pilumnopus* A. Milne Edwards, *P. serratifrons* (Kinahan), are redescribed and the genera redefined. *Heteropanope* differs from *Pilumnopus* by the lack of regional definition on the carapace; the shape of the front; the lack of an internal tooth on the lower orbital margin; and by sternite eight not being visible laterally beside the male abdomen. A new genus *Benthopanope* is described which differs from the other two genera most conspicuously by the shape of the sternal plastron. *Heteropanope convexa* Maccagno is redescribed and assigned to *Pilumnopus*. *Heteropanope sexangula* Rathbun is redescribed and assigned to *Benthopanope* gen. nov. Two new species, *Heteropanope longipedes* and *Benthopanope estuarius*, are described. *Heteropanope vincentiana* Rathbun, 1929, is re-examined and a neotype designated. It is made the type species of a new genus *Flindersoplax*, which is tentatively placed in the subfamily Carcinoplacinae of the Goneplacidae because of the wide sternal plastron, wide abdomen and structure of the first and second male pleopods. Affinities with other groups are discussed.

□ Crustacea, Decapoda, Pilumnidae, Goneplacidae, *Heteropanope*, *Pilumnopus*, *Benthopanope*, *Flindersoplax*, genus nov., species nov.

P.J.F. Davie, Queensland Museum, PO Box 300, South Brisbane, Queensland 4101, Australia; 26 January, 1989.

The status of the genera *Heteropanope* Stimpson, 1858, and *Pilumnopus* A. Milne Edwards, 1863, has long been the subject of debate. De Man (1887) and Alcock (1898) considered *Pilumnopus* to be a junior synonym of *Heteropanope*, but Balss (1933) separated them suggesting that *Pilumnopus* had a more convex and narrower carapace and the front was rounded rather than truncated. Monod (1956) cast doubt on the constancy of the characters that Balss had used and felt that only the shape of the front was of any value. He suggested that *Pilumnopus* be treated as a subgenus of *Heteropanope*. Dell (1968) pointed out that the type species of the two genera — *H. glabra* Stimpson, 1858, and *P. serratifrons* (Kinahan, 1856) — had not been compared critically and that this was of major importance before the large group of species allied to them could be properly evaluated and assigned. Takeda and Miyake (1969) followed Dell's (1968) example in maintaining them both as separate genera pending critical examination. Lim, Ng and Tan (1984) examined the larvae of *H. glabra* and after comparison with published accounts of *P. serratifrons* and other species of *Pilumnopus* felt that no useful larval characters could be discerned to separate the two genera and that this supported Monod's (1956) contention (although, in 1986, they treated the genera separately).

During studies of Australian species of Pilumnidae both *H. glabra* and *P. serratifrons* and two new species were identified in the Queensland Museum collections. Close examination resulted in the conclusion that *Heteropanope* and *Pilumnopus* were indeed generically distinct. In addition, one of the new species also proved to be sufficiently distinct to warrant the description of a new genus to accept it and several other species that had been attributed to *Pilumnopus*. The only other species of *Heteropanope* to be recorded from Australia, *H. vincentiana* Rathbun, 1929, was re-examined and found not to belong to the Pilumnidae at all, but to represent a new genus which must be placed in the Goneplacidae.

Unless otherwise stated measurements given in the text are of carapace breadth. Abbreviations are as follows: QM = Queensland Museum; NTM = Northern Territory Museum of Arts and Sciences, Darwin. Illustrations have been prepared with the aid of a camera lucida.

PILUMNIDAE Samouelle, 1819

Heteropanope Stimpson, 1858

Heteropanope Stimpson, 1858, p. 33; A. Milne Edwards, 1863, p. 288; 1867, p. 277; de Man, 1887, pp. 52-3 (in part); Alcock, 1898, p. 207 (in part); Balss, 1933, pp. 31, 32.

DIAGNOSIS

Carapace rather convex fore and aft; dorsal surface more or less smooth, regions poorly defined. Front broadly bilobed, each lobe being convex; no lateral lobule distinct from supra-orbital angle. Anterolateral margin cut into four teeth or lobes, which may be pointed but not spinous, first tooth a broad lobe confluent with the outer orbital angle. Sub-orbital margin relatively flat and without a strong tooth developed internally which can be seen from above. Sternal plastron with the fused segments 3-4 relatively long such that the telson reaches noticeably less than half the distance towards suture 2/3; sternite 8 not visible laterally beside male abdomen. Male abdomen seven segmented; first male pleopods slender, sinuous, with tip recurved.

REMARKS

Type species: *Heteropanope glabra* Stimpson, 1858, by subsequent selection by Balss, 1933, p. 32. Gender is feminine. Name 1627 on *Official List*.

Included here in *Heteropanope* are: *H. glabra* Stimpson, 1858; *H. longipedes* sp. nov. and *H. changensis* (Rathbun, 1909). The West African species *H. tuberculidens* Monod, 1956 and *H. acanthocarpus* Crosnier, 1967, are considered to probably be themselves congeneric, but not true *Heteropanope* species. *H. hilarula* (de Man, 1928) is clearly not a *Heteropanope* species but no generic allocation is attempted here without examination of specimens. *H. convexa* Maccagno, 1936, is transferred to *Pilumnopus*. *Heteropanope vincentiana* Rathbun, 1929, is removed from the Pilumnidae altogether and placed in a new genus, *Flindersoplax*, provisionally within the Goneplacidae, and described later in this paper.

No specimens of *Eurycarcinus* species have been examined by the author. On available definitions it is impossible to distinguish this genus from *Heteropanope*, and it remains to be critically appraised. For this reason, new species assignable to *Heteropanope* should also be checked against described *Eurycarcinus* species.

Heteropanope differs from *Pilumnopus* in the following characters: *Heteropanope* has the carapace regions more poorly defined; the front lacks a pre-orbital tooth; the inferior orbital margin lacks a strongly developed tooth at the inner end; the basal antennal article is comparatively much shorter and broader and its outer anterior angle projects above the level of the inner sub-orbital border; and sternite 8 is not visible laterally beside the male abdomen.

Heteropanope glabra Stimpson, 1858
(Figs 1A-J, 2)

- Heteropanope glabra* Stimpson, 1858, p. 35; 1907, p. 63, pl. 8, fig. 1; Parisi, 1916, p. 186; Yokoya, 1933, p. 184; Balss, 1933, p. 32; 1938, pp. 57, 58, fig. 2; Serène, 1973, pp. 121, 123, 124, figs 3, 4, pl. 1B, D.
non *Heteropanope glabra*: Sakai, 1939, p. 545, pl. 99, fig. 6; 1976, p. 503, text-fig. 269 (= *H. longipedes* sp. nov.).
Pilumnopus maculatus A. Milne Edwards, 1867, p. 277; 1868, p. 82, pl. 4, figs 17-19.
Eurycarcinus maculatus: de Man, 1887, p. 44, pl. 2, figs 2, 3 (not 4, 5 as indicated in the text); Ortmann, 1893, p. 435; Alcock, 1898, p. 212; Lanchester, 1900, p. 744; McCulloch, 1908, p. 7; Roux, 1917, p. 603; Sankarankuty, 1962, p. 146, fig. 51.
Achminis nudus: Grant and McCulloch, 1906, pp. 17-18. (not *A. nudus* A. Milne Edwards, 1867).

MATERIAL EXAMINED

- QM W14835, 1 ovig. ♀ (10.3 × 6.9 mm), Lim Chu Kang Rd. end, NW Singapore, in mangroves, P. Davie and P. Ng, 6.ix.1987. QM W810, 1 ♂ (11.4 × 8.3 mm) 2 ♀ (11.6 × 7.9; 10.2 × 6.9 mm), Goat Is., SEQ, 27°31'S, 153°23'E, Mud and Rock, High Water, Biol. Dept. U. of QLD, Jan, 1938. QM W5131, 3 ♂ (14.3 × 9.9; 9.8 × 7.0; 4.6 × 3.6 mm), 5 ♀ (12.3 × 8.7; 10.3 × 7.1; 9.0 × 6.2; 6.0 × 4.2; 5.9 × 4.4 mm), Serpentine Ck, SEQ, 27°24'S, 153°07'E, log litter sample, Campbell *et al.*, 3.viii.1972. QM W5161, 1 ♂ (11.9 × 8.4 mm), Serpentine Ck, SEQ, 27°24'S, 153°07'E, Campbell *et al.*, 23.viii.1972. QM W5173, 1 ♂ (21.5 × 14.9 mm), 4 ♀ (17.2 × 11.6; 16.5 × 11.1; 16.1 × 11.1, 15.7 × 10.3 mm), Serpentine Ck, SEQ, 27°24'S, 153°07'E, Campbell *et al.*, 20.ix.1972. QM W5200, 2 ♀ (15.1 × 11.0; 11.1 × 7.9 mm), Jackson's Ck, SEQ, 27°24'S, 153°06'E, Campbell *et al.*, Oct.1972. QM W5228, 1 ♂ (18.1 × 12.6 mm); 1 ♀ (6.9 × 5.2 mm), Jackson's Ck, Cribb Is., SEQ, 27°23'S, 153°05'E, Campbell *et al.*, Oct.1972. QM W5237, 2 ♀ (18.0 × 12.6; 13.0 × 9.2 mm), Jackson's Ck, Cribb Is., SEQ, 27°23'S, 153°05'E, Campbell *et al.*, 12.x.1972. QM W5267, 2 ♀ (15.3 × 10.7; 10.8 × 7.6 mm), 1 ♂ (9.6 × 6.7 mm), Serpentine Ck, Cribb Is., SEQ, 27°24'S, 153°07'E, Campbell *et al.*, 20.ix.1972. QM W5273, 1 ♂ (14.2 × 9.6 mm), Serpentine Ck, Cribb Is., SEQ, 27°24'S, 153°07'E, Campbell *et al.*, 20.ix.1972. QM W5283, 1 ♂ (9.5 × 6.7 mm) Serpentine Ck, Cribb Is., SEQ, 27°24'S, 153°07'E, Campbell *et al.*, 20.ix.1972. QM W5307, 1 ♀ (10.2 × 7.4 mm), 2 ♂ (10.6 × 7.4; 6.3 × 4.6 mm), Mary R., Northhead, Hervey Bay, SEQ, 25°26'S, 152°07'E, P. Davie, R. Timmins, 25.vii.1975. QM W5340, 1 ♂ (7.7 × 5.4 mm) Pulgul Ck, Hervey Bay, SEQ, 25°19'S, 152°54'E, R. Timmins, 23.vii.1975. QM W5354, 1 ♂ (11.7 × 8.4 mm) Moon Ck, Fraser Is., SEQ, 25°11'S, 153°04'E, near Wreck on sand bank, R. Timmins, 20.vii.1975. QM W5363, 2 ♀ (14.3 × 9.9; 5.3 × 3.8 mm) Pulgul Ck, sth of Urangan, Hervey Bay, SEQ, P. Davie, 19.vii.1975. QM W5371, 1 ♂ (5.1 × 3.7 mm), 2 ♀ (13.1 × 8.9; 7.0 × 5.4 mm) Moon Ck, Fraser Is., SEQ, 25°11'S, 153°04'E, P. Davie 21.vii.1975. QM W6788, 1

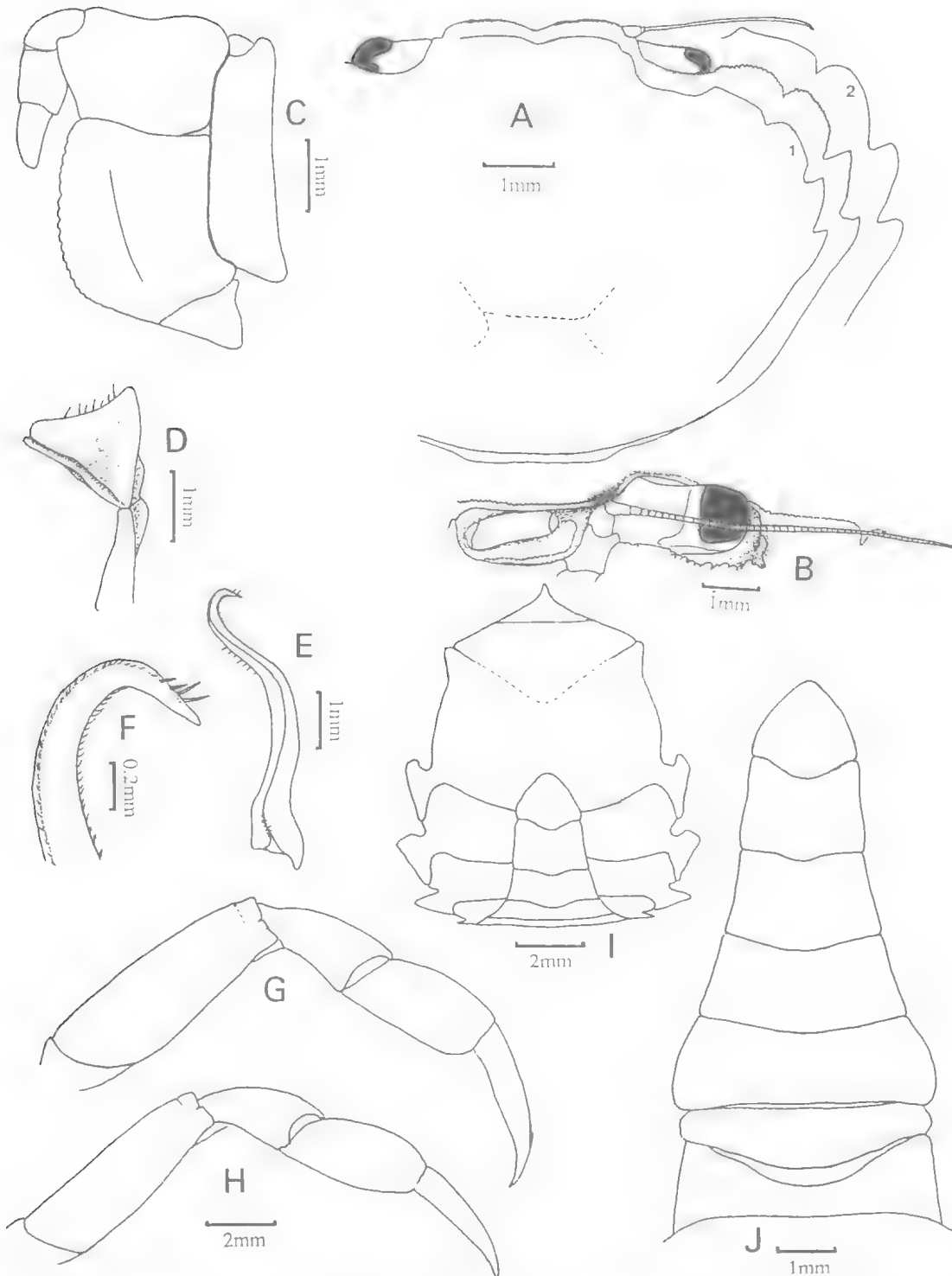


FIG. 1. *Heteropanope glabra* Stimpson, 1858 (Male, QM W5228). A, carapace outline and secondary outlines (1,2) of male and female specimens (QM W5173); B, frontal view of orbit and antennal peduncle; C, third maxilliped; D, endopod of first maxilliped (male, QM W5228); E, F, first pleopod; G, H, fourth and fifth legs respectively; I, sternum and abdomen *in situ*; J, abdomen.



FIG. 2. *Heteropanope glabra* Stimpson, 1858. Male, QM W5173, from Serpentine Creek, Moreton Bay, SEQ. Scale line in mm.

♂ (10.6×7.5 mm), Curtis Is., near Tide Is., SEQ, 23°46'S, 151°15'E, on mud in *Rhizophora*, P. Saenger, 17.xii.1975. QM W6793, 2 ♂ (15.4×10.8; 14.0×10.1 mm), 2 ♀ (11.1×7.7; 9.2×6.2 mm) Curtis Is., near Tide Is., SEQ, 23°46'S, 151°15'E, on mud in *Rhizophora*, P. Saenger, 17.xii.1975. QM W9459, 1 ♂ (12.9×9.0 mm), Susan R., SEQ, 25°26'S, 152°56'E, Holes in mud in roots, detritus etc. 26.xii.1971. QM W12391, 1 juv. (3.6×1.7 mm), Pt Farewell, East Alligator R. mouth, Kakadu, N.T., 12°07'S, 132°33'E, open mud site bordering creek in rotting roots of *Camptostemon*, P. Davie, 18.vi.1982. QM W12395, 1 ♂ (9.5×6.7 mm), Between South and East Alligator Rivers, Kakadu, N.T., 12°08'S, 132°29'E, Mangrove fringe, from rotten trunk near back edge of *Camptostemon/Sonneratia* zone, P. Davie, 2.v.1979. QM W12396, 2 ♀ (13.6×9.6; 10.0×7.2 mm, ovig), South Alligator R., Kakadu, N.T., 12°15'S, 132°23'E, West bank of mouth, Mud bank of *Brugiera* fringe, Intertidal, P. Davie, 12.v.1979. QM W12397, 1 ♂ (11.1×8.0 mm) S.W. edge of Field Is., Kakadu, N.T., 12°07'S, 132°22'E, inside base of rotting log *Rhizophora* zone, Australian Littoral Society, 3.v.1979. QM W15019, 2 ♂ (7.1×4.7; 5.1×3.6 mm), 2 ♀ (12.3×8.5; 10.8×6.7 mm), Port Douglas, NEQ, in rotting logs in harbour, P. Davie, 23.x.1982. QM W15021, 1 ♂ (9.3×6.2 mm), 2 ♀ (10.5×6.8 ovig; 9.7×6.3 mm), Portland Roads, NEQ, log infauna, seaward edge of *Rhizophora*, P. Davie, 12.xi.1982. QM W15578, 1 ♂ (10.1×7.2 mm) Murray R., NEQ, R. Timmins, May, 1978. QM W15580, 1 ♂ (12.7×8.8 mm) Redland Bay, SEQ, K. Wilson, 1.xii.1935. NTM Cr 1870, 1 ♂ (17.5×12.2 mm) Cameron's Beach, Darwin N.T., LWS Mangroves, R. Hanley, 26.ii.1982. NTM 6522, 1 ♂ (12.6×9.0 mm) Wanggi Wangji Cove, Port Essington, N.T., inside rotting bark in mud, in *Rhizophora stylosa* zone, R. Hanley, C. Watson-Russell, M. Burke, 13.ix.1985.

DESCRIPTION

Carapace wider than long (c. 1.4–1.5 times), convex along the mid-line and moderately convex from side to side across the branchial regions. Regions poorly defined: slight anterior branchial depression; gastro-cardiac grooves weakly defined; surface generally smooth although sometimes finely granular towards margins; with a few short scattered setae, and often a row of short setae on each frontal region. Frontal margin consisting of two broad, flat lobes separated by a wide V-shaped depression; granulate; with a row of very short setae just behind the edge of each lobe; separated from supra-orbital margin by an obtuse angled shoulder. Supra-orbital margin finely granular; usually without indication of median or lateral fissures; outer orbital angle slightly produced and confluent with the first anterolateral tooth. Sub-orbital margin with large granules laterally becoming smaller towards the basal antennal segment; a well defined lateral

sulcus below the exorbital angle; without an internal tooth developed. Sub-hepatic and pterygostomial regions granular; covered by short setae adjacent to maxillipeds and orbit, becoming long and feathered adjacent to merus of cheliped.

Anterolateral margin finely granular; about two-thirds length of posterolateral. Cut into four teeth: the first confluent with the outer orbital angle, broad, usually obliquely angled backwards but sometimes almost horizontal; the second a similarly broad lobe, directed anteriorly; the third slightly smaller, well separated from the second, pointed anteriorly; the fourth the smallest and also pointed. Greatest carapace breadth between the fourth pair. Posterolateral margins oblique, straight and with a line of thick feathered setae from the sub-branchial regions.

Basal antennal joint sub-rectangular; inner distal angle well separated from front; outer distal angle produced as a small lobe into the orbital hiatus; antennal flagellum relatively long and with free access to the orbit. Third maxilliped with merus much smaller than ischium (c. 0.55 times length); merus a little broader than long (c. 1.5 times), outer distal margin noticeably expanded, anterior margin concave; ischium with oblique longitudinal depression, inner margin crenellated; exopod does not reach to anterior margin of merus, and has large subdistal tooth on inner margin; surface of all segments finely granular and with short stout setae; longer bristles on inner margins of merus and ischium and on palp.

Chelipeds unequal, massive. Major cheliped with merus short, trihedral; upper posterior margin carinate with a blunt subdistal lobe; anterior margin distinctly granular proximally, becoming finer distally; lower margin smooth and rounded; a narrow fringe of longer feathered setae proximally on posterior margin, otherwise with only very short scattered setae. Carpus with a strong blunt tooth on inner margin, otherwise rounded, smooth and glabrous. Palm swollen, smooth and glabrous; superior margin rounded; length (including fixed finger) about 1.8 times height; fingers pointed, immovable finger noticeably deflexed, with very large proximal molar, and 2–3 smaller teeth reducing in size distally; dactyl strongly curved so as to leave a gape, armed with only 2–3 quite small, low teeth in proximal half; fingers both darkly coloured, except for band at base of dactyl, and colour does not extend onto palm. Smaller cheliped of similar form although less massive, no gape formed between the fingers; armed with teeth that are more triangular and sharply edged.

Walking legs of moderate length, unarmed; first and second pairs subequal in length and a little longer than the third pair; merus of third pair from 2.7–3.0 times longer than wide and of the fourth pair 2.8–3.1; dactylus about equal to length of lower margin of propodus, and terminating in an acute chitinous tip. All legs with relatively long scattered setae which become thicker on the propodus and dactylus.

Male abdomen relatively narrow: first, second and third segments of similar width; segments four to seven of similar length, tapering; telson about as wide as broad at base, bluntly pointed. Sternite eight hidden laterally beneath the second abdominal segment. First male pleopod sinuous, with downturned pointed beak; a fine line of short fringing setae distally on the inside curve and along the outer suture line; 3–4 longer, stouter setae on the top of the beak.

HABITAT

Intertidal, in muddy and mangrove environments, usually inside rotting logs or stumps, or in crevices in the substrate. Tolerates lower estuarine salinity conditions. *H. longipedes* sp. nov. occurs sympatrically in Australia.

DISTRIBUTION

Hong Kong (type locality), Mergul Archipelago, Singapore, Zanzibar, New Caledonia and northern Australia. The record from Japan of Yokoya (1933) is doubtful (see remarks).

REMARKS

The present specimens agree closely with the description and figures of Stimpson (1858, 1907). Serène (1973) notes that the holotype can be presumed lost, destroyed with most of Stimpson's specimens in the Chicago fire of 1871. He mentions that a neotype should be erected and appears to suggest that the type of *Pilumnopus maculatus* A. Milne Edwards, 1867, if it is in good condition, should be given that status. This would be inadvisable as although it almost certainly belongs to this species it would create a difficult situation if differences could be demonstrated. Further the Zanzibar locality is far removed from Hong Kong and recommended practise is to choose a specimen from as close as possible to the type locality. For this reason I have chosen not to erect a neotype at this time although this must be done as soon as a suitable specimen becomes available.

Comparing the figures of the first male pleopod (Sankarankutty, 1962, fig. 51; Serène, 1973, figs

3,4; present paper) it is apparent there is some variation in the degree of deflection and the length of the tip, and in the setation. These differences are slight however, and unlikely to be of significance.

Grant and McCulloch's (1906) errant record of *Actumnus nudus* was probably caused by the mis-numbering of figures in de Man (1887) (see synonymy).

The record of Yokoya (1933) from a depth of 126 m in Tosa Bay, Japan must be considered as doubtful as all other records indicate this species to belong to the shallow subtidal or intertidal muddy shore.

Heteropanope longipedes sp. nov. (figs 3A–K, 4)

Heteropanope glabra: Sakai, 1939, p. 545, pl. 99, fig. 6; 1976, p. 503, fig. 269. (non *Heteropanope glabra* Stimpson, 1858).

MATERIAL EXAMINED

HOLOTYPE: QM W5352, ♂ (22.6 × 15.0 mm), Moon Ck, Fraser Island, SEQ, 21.vii.1975, P. Davie and R. Timmins.

PARATYPES: QM W15656, 1 ♀ (12.8 × 9.0 mm), Susan River, Hervey Bay, SEQ, from mud and detritus in mangroves, 26.xii.1971, R. Timmins. QM W5356, ♀ (11.5 × 7.9 mm), northern tip of Stewart Island, Hervey Bay, in logs and on mud around mangroves, 6.vii.1975, P. Shanco. QM W8229, 1 ♂ (16.1 × 10.8 mm) 1 ♀ (11.9 × 8.3 mm), Murray River, north of Cardwell, NEQ. Mangrove covered island near mouth, log infauna, 14.x.1978, P. Davie. QM W8231, ♀ (16.0 × 11.3 mm), Murray River, north of Cardwell, NEQ, May 1978, R. Timmins. QM W8232, ♂ (13.7 × 9.5 mm), Murray River, north of Cardwell, NEQ, log infauna, 19.v.1978, R. Timmins. NTM Cr 3710, 1 ♂ (12.4 × 8.7 mm), Creek 'H', East Arm, Darwin, Northern Territory, 4 m in mangrove creek, 31.x.1984, R. Hanley. NTM Cr 1700, ♀ (8.7 × 6.1 mm), juv. ♀ (6.4 × 4.7 mm), 12°34.2'S, 130°56.3'E, N.T., in mangroves at low water spring, 17.v.1984, J.R. Hanley. NTM Cr 3074, juv. ♀ (9.8 × 6.8 mm), Creek 'H', East Arm, Darwin Harbour, N.T., in mangroves at low water spring, 4.ii.1985, R. Hanley. NTM Cr 3713, 1 ♀ (7.9 × 5.6 mm) East Arm, Darwin, NT, Ck 'H', mangrove creek 4 m, 31.x.1984, R. Hanley.

DESCRIPTION

Carapace strongly convex front to back and from side to side across the branchial regions. Regions poorly defined with only the gastroducardiac grooves and the longitudinal median frontal groove which is bifid posteriorly around the anterior extension of 3M. Surface appearing smooth and glabrous but evenly microscopically

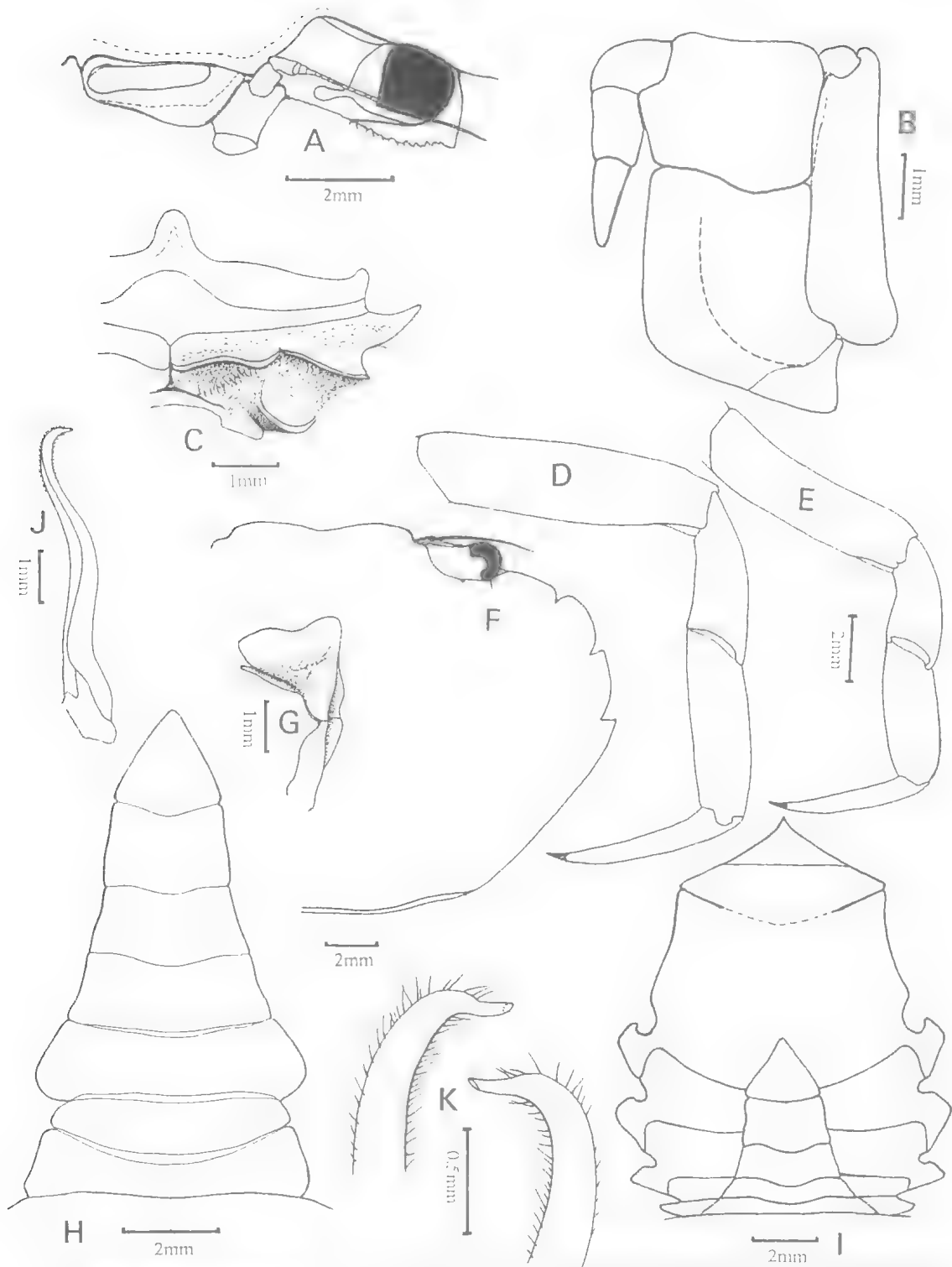


FIG. 3. *Heteropanope longipedes* sp. nov., holotype male. A, frontal view of orbit and antennal peduncle; B, third maxilliped; C, epistome; D, E, fourth and fifth legs respectively; F, carapace outline; G, endopod of first maxilliped; H, abdomen; I, sternum and abdomen in situ; J, first pleopod; K, abdominal and sternal views of tip of first pleopod.

granular; without any dorsal setation. The front is moderately produced with a broad shallow median emargination; no preorbital lobes; margin microscopically beaded. Supra-orbital border clearly separated from front by a rounded, obtuse, angle; vestiges of orbital fissures noticeable, one about mid-margin, the other about half-way to the external orbital edge. Infra-orbital margin relatively straight, without an inner lobe or tooth being developed and ending in a smooth sulcus laterally below the first anterolateral tooth; finely tuberculate on inner third becoming coarsely tuberculate on outer two-thirds before the sulcus.

Sub-hepatic and pterygostomial regions granulate and evenly covered in short close setae anteriorly, becoming abruptly long and shaggy posteriorly in a curving line from above the coxa of the cheliped to the anterior edge of the third anterolateral tooth.

Anterolateral margins cut into four teeth: the first a broad flat lobe confluent with the outer orbital margin; the second of similar size and rounded; the third also of similar size, bluntly pointed anteriorly, flat almost perpendicular margin; the fourth much smaller and subacute; greatest carapace breadth between the fourth anterolateral teeth.

Basal antennal joint broad, subquadrate; inner distal edge approaching but not touching the front, outer distal edge prolonged as a short rounded lobe into the orbital hiatus; antennal flagellum with free access to the orbit. Third maxilliped with merus much smaller than ischium (c. 0.6 times length); merus a little broader than long (c. 1.3 times); surface of both segments and exopod regularly covered in short setae, inner margin of ischium with a row of longer bristles; exopod reaching to anterior margin of merus and with a large rounded inner subdistal lobe.

Chelipeds very unequal. Major cheliped massive, merus trihedral, unarmed except for strong, blunt, subdistal lobe on upper posterior margin; lower margin rounded, upper anterior and posterior margins edged with long feathery setae; carpus with a blunt tooth medially on inner margin, otherwise rounded; palm swollen rounded, length (including fixed finger) about 1.8 times height; fingers bluntly pointed, length of dactyl about equal to superior margin of palm, fixed finger slightly deflexed, small gape, fingers armed with large molariform teeth. Smaller cheliped similar but palm more slender and teeth on fingers more triangular and cristate. Dark colouring on fingers confined to distal three-

quarters of dactyl and about the distal half of the fixed finger.

Walking legs relatively slender, unarmed; first three pairs subequal in length, fourth pair the smallest; meri about 3.8–3.9 times longer than wide. Dactyli relatively long and slender, a little longer than the propodi and terminating in acute chitinous tips. Legs sparsely setose.

Male abdomen relatively narrow; first segment slightly wider than the third, second a little constricted; penultimate segment about two thirds as long as wide; telson triangular, sharply pointed, as long as broad at base. First male pleopod sinuous, with recurved, narrowed tip; a line of setae on upper and lower surfaces (as figured).

HABITAT

Lives intertidally in muddy environments usually inside rotting logs or stumps, or in crevices in the substrate. Tolerates lower estuarine conditions. Habitat and distribution overlap with *H. glabra* Stimpson.

DISTRIBUTION

Known from northern Australia from south-eastern Queensland to Darwin in the Northern Territory; and from Palau Is., east of the Philippines (Sakai, 1939, 1976).

REMARKS

Heteropanope longipedes sp. nov. is most closely related to *H. glabra* Stimpson, from which it can be easily separated by the noticeably longer, more slender, relatively naked walking legs; the different shape of the anterolateral teeth, and in particular the third tooth which is longer and less protruding; and the structure of the first male pleopod.

H. longipedes differs from *Eurycarcinus natalensis* (Krauss, 1843) by the different shapes of the anterolateral angles and first male pleopod. It differs from both *Eurycarcinus integrifrons* (de Man, 1879) and *E. orientalis* A. Milne Edwards, 1868, by the longer more slender legs (particularly the slender propodi) which are almost naked. In particular it differs from *E. integrifrons* by having a strongly bilobed front (*E. integrifrons* has a straight front which may be slightly emarginate in the middle); and in the shape of the anterolateral teeth. De Man (1879) describes the last two teeth of *E. integrifrons* as being dentiform whereas only the last tooth of *H. longipedes* can be considered dentiform. De Man also describes them as 'projecting much less than in *Euryc. Grandidieri* or in *Euryc. Natalensis* Krauss'. This is shown in Nobili



FIG. 4. *Heteropanope longipedes* sp. nov., holotype male. Scale line in mm.

(1906b, pl. xi, fig. 2) and in small specimens these teeth are apparently even less distinct (see discussion in Balss, 1938, p. 58).

In *E. orientalis* the anterolateral border is distinctly less than two-thirds the length of the posterolateral border, while in *H. longipedes* it is about two-thirds (c. 0.67) and in adult *E. orientalis* the length to breadth ratio is about 1.65 as opposed to c. 1.5 in *H. longipedes*.

Pilumnopus A. Milne Edwards, 1863

Pilumnopus A. Milne Edwards, 1863, p. 289; Balss, 1933, p. 33; Sakai, 1939, p. 542; Dell, 1968, pp. 18, 19; Takeda and Miyake, 1969, pp. 120-21 (in part); Manning and Holthuis, 1981, p. 151.

Heteropanope (in part): de Man, 1887, p. 52; Alcock, 1898, p. 207.

Heteropanope (*Pilumnopus*): Monod, 1956, p. 264

DIAGNOSIS

Carapace rather convex fore and aft; dorsal surface marked, more or less, by hairy granular crests, and regions moderately defined. Front bilobed with each lobe more or less convex; a distinct lateral lobule defined, separate from the supra-orbital angle. Anterolateral margin cut into four teeth or lobes, which may be pointed but not spinous; first tooth a broad lobe confluent with the outer orbital angle. Sub-orbital margin with a very large tooth at inner end which is visible in dorsal view. Sternal plastron with the fused segments 3-4 relatively long such that the telson reaches noticeably less than half the distance towards suture 2/3; sternite 8 is visible laterally beside male abdomen. Male abdomen seven segmented; first male pleopod slender, sinuous with tip recurved.

REMARKS

No nominal species were included in this genus. Type-species: *Pilumnopus crassimanus* A. Milne Edwards, 1867, a subjective junior synonym of *Ozius serratifrons* Kinahan, 1858, by subsequent designation by Balss, 1933 pp. 33, 34. Gender is masculine. Name 1863 on Official List, there dated 1867 in error.

Pilumnopus is separated from *Heteropanope* by the characters discussed under that genus.

Included in *Pilumnopus* are: *P. serratifrons* (Kinahan, 1858); *P. convexa* (Maccagno, 1936); *P. salomonensis* Ward 1942 (? = *P. convexa*); *P. granulata* Balss, 1933; *P. makiana* (Rathbun, 1929); *P. marginatus* (Stimpson, 1858); and tentatively *P. vauquelini* (Audouin, 1826), *P. sinensis*

Balss, 1933, and the West African species *P. caparti* (Monod, 1956). Other species have been referred to *Benthopanope*.

The identity of *P. salomonensis* is in question. It is impossible to distinguish from *P. convexa* on the basis of Ward's short description and poor figure. The type, from the Desjardins Museum in Mauritius, was unavailable for examination in time to be included in this manuscript.

Pilumnopus serratifrons (Kinahan, 1856) (Figs 5A-I, 6)

Ozius (?) *serratifrons* Kinahan, 1856, p. 118, pl. 4, fig. 1

Pilumnopus crassimanus A. Milne Edwards, 1867, p. 278.

Pilumnopus serratifrons: Miers, 1876, p. 20; Haswell, 1882, p. 70, pl. 2, fig. 1; Miers, 1884, p. 228; Filhol, 1885, p. 379; Fulton and Grant, 1906, p. 18; Chilton and Bennett, 1929, p. 749; Balss, 1933, p. 34; Richardson, 1949, p. 130; Dell, 1968, pp. 19-20; Takeda and Miyake, 1969, pp. 94, 120, 130; Griffin and Yaldwyn, 1971, pp. 56-7.

Sphaerosius (?) *serratifrons*: Miers, 1886, p. 144.

Heteropanope serratifrons: de Man, 1890, p. 56, pl. 3, fig. 2; Hale, 1927, p. 161, fig. 162.

MATERIAL EXAMINED

QM W15096, 4 ♂ (8.6 × 6.5, 20.0 × 14.8; 22.1 × 16.4; 27.6 × 20.2 mm), 2 ♀ (14.0 × 10.1; 17.6 × 12.7 mm), Cudgera Creek, Hastings Point, northern N.S.W., under oyster rocks, 15.v.1988, P. Davie. QM W1066, 1 juv. (7.0 × 5.3 mm) Stradbroke Is., N. of Myora, SEQ, mud and sand; University of Queensland Science Student Association, 16.vii.1939. QM W2319, 8 ♂ (16.2 × 12.4; 12.6 × 9.6 [with Sacculina]; 10.5 × 8.0; 10.0 × 7.2, 8.6 × 6.2, 7.9 × 6.0 [with Sacculina]; 7.7 × 5.7; 6.8 × 4.9 mm), 1 ♀ (6.5 × 4.9 mm), Dunwich, SEQ, from Sponge, F.C. Vohra. QM W2372, 2 ♂ (19.2 × 14.6; 18.2 × 14.0 mm), Dunwich, SEQ, Zostera, F.C. Vohra. QM W4753, 1 ♂ (14.1 × 10.9 mm) Coomera Is., near Southport, SEQ. R. Timmins (Aust. Litt. Soc.) 28.vii.1974. QM W5278, 1 ♀ (10.2 × 7.6 mm) Serpentine Ck, Cribb Is., SEQ. Campbell *et al.* 20.ix.1972. QM W5301, 1 ♂ (6.8 × 5.0 mm) Moon Ck, Fraser Is., SEQ, from log on bank of channel close to mouth, P. Davie, R. Timmins, 20.vii.1975. QM W5343, 1 ♀ (9.2 × 6.8 mm), Moon Ck, Fraser Is., SEQ, P. Davie, 21.vii.1975. QM W5347, 1 ovig. ♀ (11.1 × 8.1 mm), Eli Ck, Hervey Bay, SEQ, in rotting wood, below low water mark in channel, P. Davie, 26.vii.1975. QM W5401, 1 ♂ (4.2 × 3.0 mm), 4 ♀ (11.6 × 8.7; 7.5 × 5.5 ovig.; 7.2 × 5.3 ovig.; 5.6 × 4.2 mm) Moon Ck, Fraser Is., SEQ, from wreck about 1 km from mouth, R. Timmins 20.vii.1975. QM W6422, 1 ♂ (11.0 × 8.3 mm), 1 ovig. ♀ (10.9 × 7.8 mm), Bogimbah Ck, Fraser Is., SEQ, rotting log on mudflats in front of creek, P. Davie, 22.vii.1975. QM W6423, 1 ♂ (8.1 × 6.2 mm) 1

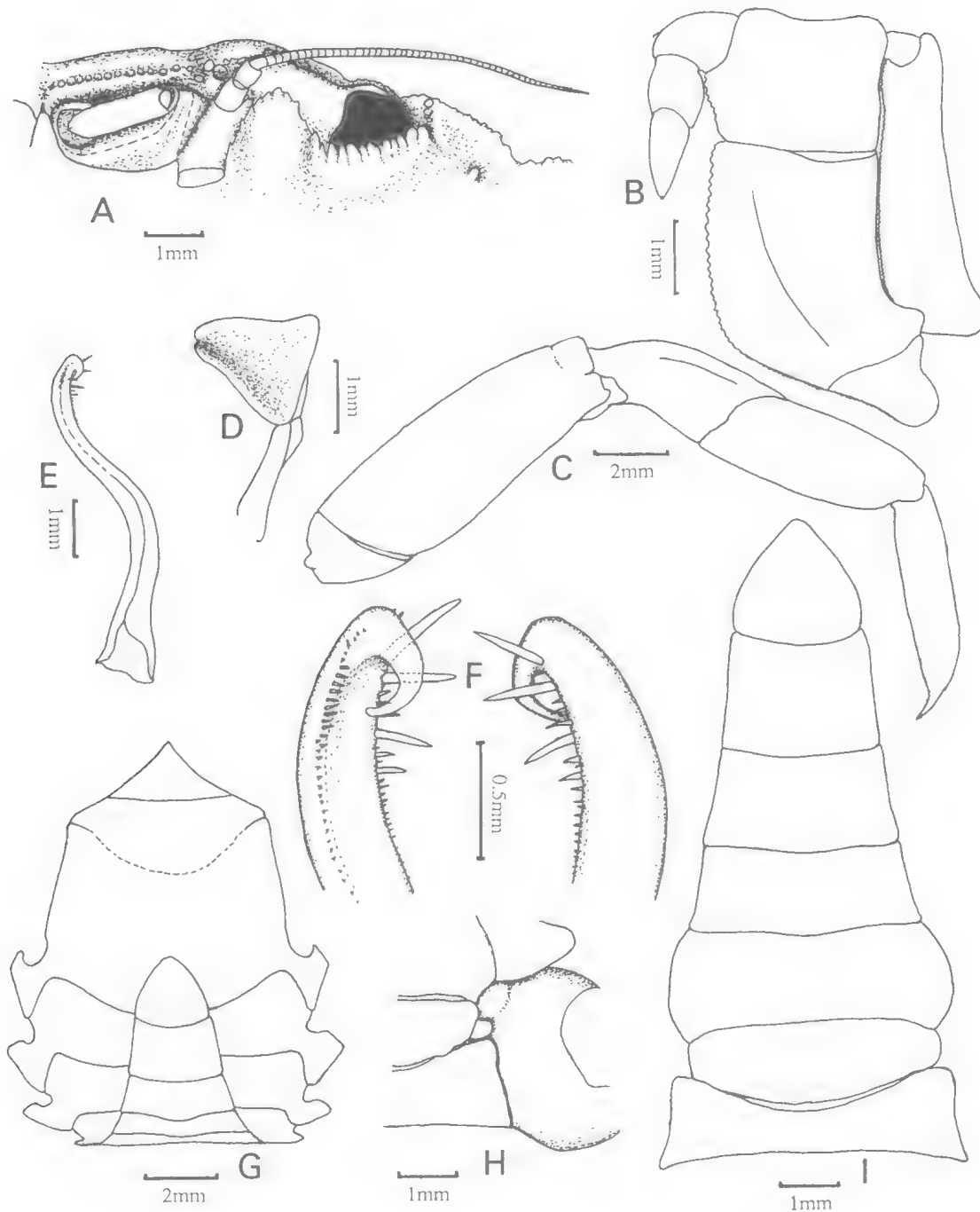


FIG. 5. *Pilumnopeus serratifrons* (Kinahan, 1856), QM W15096, A, D-I of male 20.0 mm c.b., B and C of male 22.1 mm c.b. A, frontal view of orbit and antennal peduncle; B, third maxilliped; C, fourth leg; D, endopod of first maxilliped; E, first pleopod; F, abdominal and sternal views of first pleopod; G, sternum and abdomen in situ; H, lateral view of abdomen and coxa of last leg showing sternite eight visible beside abdomen; I, abdomen.

ovig. ♀ (8.3×6.2 mm) Moon Ck, Fraser Is, SEQ, log infauna, R. Timmins 20.vii.1975. QM W15541, 1 ♀ (12.7×9.3 mm) Bulwer Is, Brisbane R., SEQ, under rocks on mud at low tide, coll. Short *et al.*, 12.vii.1988. QM W15547, 1 ♂ (9.8×6.0 mm) Boggy Ck, Myrtle-town, SEQ, under rocks near low tide mark, Short *et al.*, 12.vii.1988. QM W15576, 1 ♀ (22.7×17.1 mm) Melbourne, Vic., C. Noone, 12.ii.1982.

DESCRIPTION

Carapace wider than long (c. 1.3–1.4 times), convex along the mid-line, particularly in the frontal third, and moderately convex from side to side across the branchial regions. Regions moderately well defined with short granular, hairy, crests on frontal and epigastric regions, and longer ones on protogastric and epibranchial regions; gastro-cardiac grooves distinct. 3M distinguishable although not strongly defined; a medial furrow joins 3M to frontal margin. Dorsal surface with small rounded granules laterally, which vary in extent of cover between specimens, but usually most obvious behind the epibranchial teeth and posterolaterally. Frontal margin sharply granular, prominently projecting, deeply declivous, borders oblique, receding to strong, lateral pre-orbital spines. Supra-orbital margin elevated, evenly concave, separated from pre-orbital spine by a broad shoulder; lined by rounded granules; median and lateral fissures vestigial but more-or-less obvious; outer orbital angle confluent with first anterolateral tooth. Sub-orbital margin with coarse pointed granules; distinct narrow lateral sulcus; internally with very strongly developed, tuberculate lobe, clearly visible dorsally. Sub-hepatic and pterygostomial regions granular, thickly covered in long feathered setae adjacent to merus of cheliped and below anterolateral margins; a strong, prominent sub-hepatic tubercle present below the margin of the first anterolateral tooth and slightly below the level of the lateral suborbital notch.

Anterolateral margin granular, a little shorter than posterolateral, cut into four teeth: the first confluent with the outer orbital angle; the second, the largest, forwardly directed and bluntly rounded; the third similar, but smaller and acute; the fourth much smaller and also acute. Greatest carapace breadth between the fourth anterolateral teeth. Posterolateral margins oblique, straight and becoming thickly covered in feathered setae posteriorly.

Basal antennal joint sub-rectangular, inner distal angle just touching front; outer distal edge produced as a thin lobe into the orbital hiatus (sometimes this prolongation is more-or-less

hidden behind the tubercles of the large inner orbital lobe); antennal flagellum with free access to the orbit. Third maxilliped with merus much smaller than ischium (c. 0.55 times length); merus a little broader than long (c. 1.3 times), outer distal margin slightly expanded, rounded, anterior and outer lateral margins slightly concave; ischium with oblique longitudinal depression; internal margins of both segments with a series of large rounded granules hidden by a row of stout bristles, outer surface smooth or microscopically granular and with short scattered setae; exopod does not quite reach to anterior margin of merus, with large rounded triangular subdistal tooth on inner margin, internal edge adjacent to merus and ischium with a line of granules.

Chelipeds unequal, massive. Major cheliped with merus short, trihedral, armed with a strong, acute subdistal spine on upper posterior margin; lower margin rounded; upper anterior and posterior margins granulate and with long feathered setae which also extend onto the upper half of the posterior face. Carpus with strong acute tooth on inner margin, with an oblique downwardly directed crest proximal to it which usually terminates in a sharp tubercle; the main tooth has a low granular crest running behind it back to the articulation, which defines a downturned, oblong facet internally; upper surface slightly uneven with some microscopically granular patches distally and posteriorly. Palm swollen, in larger specimens the surface is microscopically granular, slightly coarser towards superior and proximal margins, but this is variable, and on smaller specimens particularly, the granulation may be quite coarse; superior margin rounded; length (including fixed finger) about 1.6–1.7 times height; fingers bluntly pointed, both armed with 2–3 large molariform teeth, dactyl short, about equal to length of superior margin of palm, closes behind tip of fixed finger; fixed finger slightly deflexed; fingers are both coloured entirely dark brown, and colour does not extend onto palm. Smaller cheliped less massive; fingers longer, more sharply pointed and of the same length; armed with about four teeth which are relatively small, and cristiform.

Walking legs of moderate length, unarmed; second and third pairs subequal in length and slightly longer than first pair; merus of third walking leg about 2.8 times as long as wide, dactylus slightly longer than propodus, terminating in an acute chitinous tip. All legs fringed with long feathered setae, extending onto upper face of the propodus, and dactylus covered in a short thick tomentum from which chitinous claw protrudes.



FIG. 6. *Pilumnopus serratifrons* (Kinahan, 1856). Male, QM W15096 from Cudgera Creek, Hastings Point, northern NSW. Scale line in mm..

Male abdomen relatively narrow: first and third segments subequal in width and wider than other segments; second segment constricted but wider than segments 4–7; segments 4–7 become progressively longer, telson rounded triangular, with length about equal to width at base. Sternite eight is just visible beside the second abdominal segment although not prominent, usually being almost hidden by fringing hairs on abdomen. First male pleopod markedly sinuous, tip strongly recurved and thin; several very large, stout setae along the inside edge near the tip.

HABITAT

Usually found in the lower estuary or on sandy mud flats, living under stones and debris resting on the substrate, from about half tide level to low water.

DISTRIBUTION

Temperate to sub-tropical Australia from South Australia around to about Fraser Island in southern Queensland; and in New Zealand.

REMARKS

This is a distinctive and common Australian species. Larval development has been described by both Wear (1968) and Greenwood and Fielder (1984a).

Pilumnopus convexa (Maccagno, 1936) (Fig. 7A–C)

Heteropanope convexa Maccagno, 1936, pp. 176–7.

(?) *Pilumnopus indica*: Barnard, 1955, pp. 30, 31, fig. 12 (not *Pilumnopus indica* (de Man, 1887)).

MATERIAL EXAMINED

LECTOTYPE: 1 ♀ (8.0 × 5.3 mm), Aseb (= Assab), Ethiopia, collected by Barone Raimondo Franchetti Exped., 1928–1929. Specimen housed in the Museo Civico di Storia Naturale "Giacomo Doria", Genova.

DESCRIPTION

Unfortunately the specimen has been subjected to dehydration so surface detail is difficult to accurately appreciate.

Carapace strongly convex anteriorly and from side to side across the branchial regions. Regions moderately well indicated, with the inner orbital regions being strongly elevated. Surface is finely granular across the front, laterally behind the anterolateral teeth, and to a slight extent posterolaterally. Sparse rows of plumose setae are evident across the frontal regions on the edge of the orbit, on the lateral branchial regions at about the level of 2L–3L, medially towards the level of the anterior margin of 2M, around the base of the last anterolateral tooth, and running along the slightly raised and curved epibranchial ridge; and thicker postero-laterally and across the posterior margin.

The front is slightly produced and cut into two oblique lobes by a broad shallow V-shaped notch; laterally with small but clearly defined pre-orbital lobes; margin is smooth or microscopically granular. The supra-orbital border is clearly separated from the front by a small sinus; traces

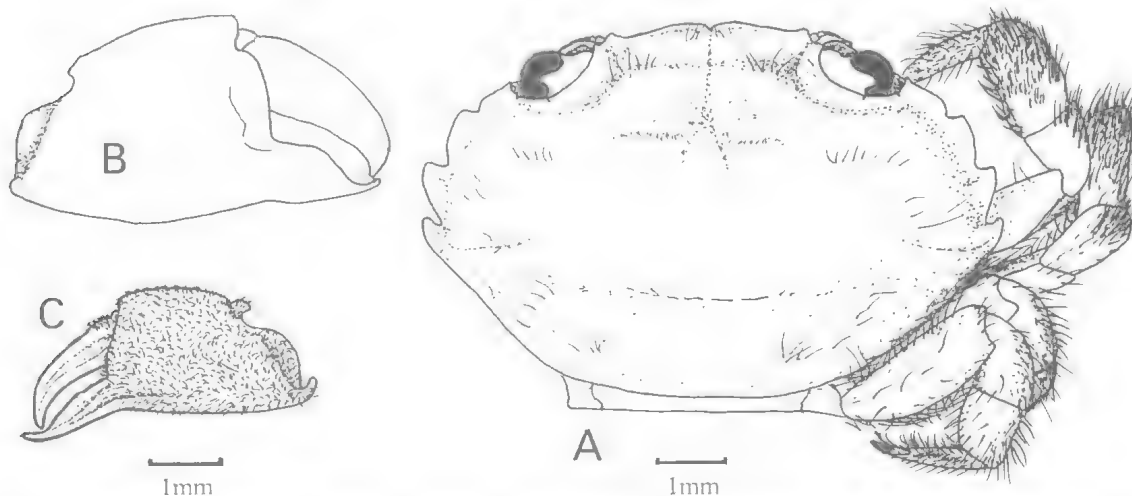


FIG. 7. *Pilumnopus convexa* (Maccagno, 1936), lectotype female. A, dorsal view of carapace and walking legs; B, C, major and minor chelae.

of two notches are evident on the outer half; regularly curved. Both supra- and infra-orbital borders microscopically granular although slightly more prominent on the infra-orbital border. Infra-orbital margin with a deep notch laterally and with a broad rounded lobe at the inner angle which is visible dorsally.

The anterolateral border is armed with four teeth; the first is low, broad, sinuous, and confluent with the external orbital angle; the second to fourth are all directed forwards; the second is broad with the outer margin convex, the third of similar form but narrower and more acute, the fourth is a more regular blunt spine. The subhepatic region has a blunt protruberance below the first anterolateral tooth; and is regularly covered in short setae.

Third maxilliped covered in short setae. Merus shorter than ischium; sub-quadrate, and expanded at the antero-external angle.

Chelipeds unequal. Merus short, trihedral, unarmed except for short subdistal spine on posterior margin. Carpus coarsely granulated on the outer surface and, on the lectotype female, with inner angle acute rather than spinous; a broad groove present parallel to the distal margin. The larger palm is stout and granulated both on the upper surface, and proximally around the articulation with the carpus; fingers pointed and with sharp cutting margins; immovable finger downturned and about a half as long as the lower border of the palm. Smaller palm of similar overall appearance except more slender and, with the exception of the fingers, evenly covered in short setae.

Ambulatory legs are comparatively short and stout; the length of the merus of the fourth pair c. 0.29 times the breadth of carapace and about 2.6 times longer than wide. All are thickly covered with short plumose or simple setae, especially the propodus and dactylus.

DISTRIBUTION

Aseb, southern Red Sea (type locality); and questionably from Durban Bay, South Africa (Barnard (1955) as *Pilumnopus indica*).

REMARKS

This species has not been recorded since its description. As a holotype was not designated originally, the female examined above is designated the lectotype.

Unfortunately the present specimen has suffered a period of dessication and although it has been returned to a wet state, fine wrinkling obscures

some of the surface detail (such as fine granulation) and the hairs have become clumped which makes it difficult to appreciate their fresh appearance. Also the regions seem to be somewhat more accented than they would probably be in fresh specimens.

This species is very closely related to *P. serratifrons* from which it differs by the length/breadth ratio (1.47–1.51 as opposed to 1.34–1.38) and the less projecting front with a shallower central notch. The disposition of setae on the carapace and legs is very similar in both species although *P. convexa* has a good coverage of short setae on the minor chela (at least on the lectotype female).

Takeda and Miyake (1969) have already indicated that Barnard's (1955) record of *Pilumnopus indica* from South Africa was erroneous. They suggested that its true identity may be *P. salomonensis* Ward. *P. salomonensis* is very poorly known and may well itself be a junior synonym of *P. convexa*. The type of *P. salomonensis* was requested from the Desjardins Museum, Mauritius, but it was unavailable as it was already on loan. Ng (in litt.) has examined the type of *P. salomonensis* and is of the opinion that the two species should remain separate until a greater range of specimens has been examined. There appear to be some differences in the larger chela but these may prove to be size related.

Barnard's (1955) figure of the dorsal surface of his '*Pilumnopus indica*' is almost identical to the lectotype of *P. convexa*, and the length/breadth ratios are also very similar (1.47–1.50 in his specimens, 1.51 in the lectotype of *P. convexa*). The major chela agrees with his description of the granulation i.e. upper surface and on outer surface near wrist. The palm of the minor chela of the female lectotype is covered in short setae but this has not been figured or described by Barnard. Setation could be variable depending on size and sex.

Heteropanope gen. nov.

DIAGNOSIS

Carapace convex in the mid-line; regions strongly defined by granular dorsal crests; gastrocardiac grooves clearly indicated; more or less finely granular. Frontal margin protruding with prominent median lobes, more or less sinuous laterally with distinct lateral lobules. Anterolateral margin cut into four or sometimes five teeth (the first lobe may develop a secondary tooth separate from the outer orbital angle). Sub-orbital margin with a large triangular tooth at the inner

end which is visible in dorsal view. Sternal plastron with the fused segments 3–4 relatively short and broad such that the telson reaches much more than half the distance towards suture 2/3; sternite 8 is clearly visible laterally beside the male abdomen. Male abdomen seven segmented; first male pleopod slender, sinuous, with tip recurved.

REMARKS

Type-species is *Benthopanope estuarius* sp. nov.; gender is feminine. Species I believe should be included, besides the type-species, are: *B. sexangula* (Rathbun, 1909); *B. eucratoides* (Stimpson, 1858); *B. indica* (de Man, 1887); *B. pharaonica* (Nobili, 1906); and the West African species *B. africanus* (de Man, 1902). Of these however all except *B. sexangula* still await critical examination.

Benthopanope differs markedly from *Heteropanope* and *Pilumnopus* by the strong regional definition on the carapace and the unusual shape of the sternal plastron in having sternites 3–4 relatively much shorter and broader. It differs in particular from *Heteropanope* by having sternite 8 visible laterally beside the male abdomen.

Benthopanope estuarius sp. nov. (Figs 8A–K, 9)

Heteropanope sexangula: Rathbun, 1924, pp. 21–22.
(Not *Heteropanope sexangula* Rathbun, 1909).

MATERIAL EXAMINED

HOLOTYPE: QM W15587, ♂ (18.5 × 14.0 mm), Calliope R., SEQ, 14.i.1977, P. Saenger.

PARATYPES: QM W13196, 4 ♂ (15.0 × 11.4; 17.2 × 12.9; 19.4 × 14.8; 20.2 × 15.2 mm), 1 ovig. ♀ (11.8 × 8.6 mm), Embley River, 1 mile upstream of junction with Hay River, Gulf of Carpentaria, Beam trawled, 13 p.p.t., salinity, 4.3, 1987, T. Wassenburg. QM W 6844, ♀ (6.8 × 5.3 mm), Lower Anabranche, Calliope River, Port Curtis, edge of channel, Aug. 1976, P. Saenger. QM W6845, ♀ (4.8 × 3.8 mm), Lower Anabranche, Calliope River, Port Curtis, mid-channel, Aug. 1976, P. Saenger. QM W6843, ♂ (4.7 × 3.7 mm), imm. ♀ (4.6 × 3.5 mm), 5 km from Alexandra Inlet mouth, edge of channel, Port Curtis, Aug. 1976, P. Saenger. QM W6822, imm. ♀ (4.6 × 3.6 mm), Lower Anabranche, Calliope River, Port Curtis, May 1976, P. Saenger. QM W15657, ♂ (10.6 × 8.1 mm), under coral rubble on sandflat, south of mouth of Stewart River, Port Stewart, NEQ, 7.xi.1982, P. Davie. QM W15044, ♀ (10.1 × 7.7 mm), ovig. ♀ (9.5 × 7.1 mm), Rocky Point, Weipa, under rocks on muddy sand above M.T.L., 29.v.1973, B. Campbell. QM W13109, ♂ (15.2 × 11.3 mm), ovig. ♀ (11.1 × 8.0 mm), Murray River, north of Cardwell, NEQ, 19.v.1978, P. Davie. QM W13108, imm.

♂ (13.9 × 9.9 mm), Murray River, north of Cardwell, NEQ, 21.v.1978, R. Timmins. NTM Cr 3049, juv. (3.9 × 2.9 mm), Adelaide River, mouth, N.T., 5–8 m, shell grit, pebbles, silt, dredge sample, 21.v.1985, R. Hanley. NTM Cr 1291, ovig. ♀ (9.7 × 7.2 mm), Northern Territory, N.T. Fisheries. NTM Cr 3589, ♂ (16.9 × 12.8 mm), Barrow Bay, Pt Essington, N.T., mudflat, L.W.S., 18.ix.1985, R. Hanley. NTM Cr 6523, ovig. ♀ (8.3 × 6.2 mm), West side of Barrow Bay, Port Essington, N.T., mudflat in front of mangrove on west side of Bay, L.W.S., R. Hanley *et al.*, 18.ix.1985. NTM Cr 6524, ovig. ♀ (12.3 × 8.9 mm), West Bay, Port Essington, in mud on mudflat in front of mangroves, M.L.W., R. Hanley *et al.* 14.ix.1985. NTM Cr 6525, ♂ (15.8 × 11.9 mm), Gove, N.T., Weed zone, 20.iv.1972, N.T. Fisheries Service.

DESCRIPTION

Carapace convex along the mid-line, almost flat from side to side across the branchial regions but depressed laterally before the upturned anterolateral teeth; approx. 1.3 times broader than long in adults (1.32 in the holotype, 1.26–1.37 in paratypes). Regions strongly defined by granular dorsal crests; transverse on frontal, epigastric and protogastric regions; obliquely curved hepatic; curved anterior branchial; slightly divergent longitudinal crests on the posterior branchial regions forming the outer borders of lateral, flat, oblong areas. The gastro-cervical and cardiac grooves are clearly indicated and the region 3M and the cardiac region are clearly defined. Dorsal surface finely granular. Frontal margin protruding with prominent, narrow, rounded central lobes, laterally becoming flat or slightly sinous, before the small rounded outer lobes; clearly separated from supra-orbital border by a rounded obtuse angle. Supra-orbital border with clearly defined vestigial fissures, in the form of sulci, one medially and one laterally before the prominent outer orbital angle. Infra-orbital border with small but distinct sulcus laterally; and with very strong triangular lobe on inner half which is clearly visible in dorsal view. Sub-hepatic and pterygostomial regions granular, longer setae adjacent merus of cheliped and along groove separating sub-hepatic region and pterygostome.

Anterolateral margins cut into five teeth including the external orbital angle; the second, the smallest, a small evenly rounded lobe confluent with but clearly separated from the external orbital angle; the third a large, forwardly directed flat lobe; the fourth smaller, rounded; the fifth about the same size as the second but more pointed and swollen dorsally; sometimes a raised granulate crest is present on the posterolateral margin just behind the last anterolateral tooth. Greatest

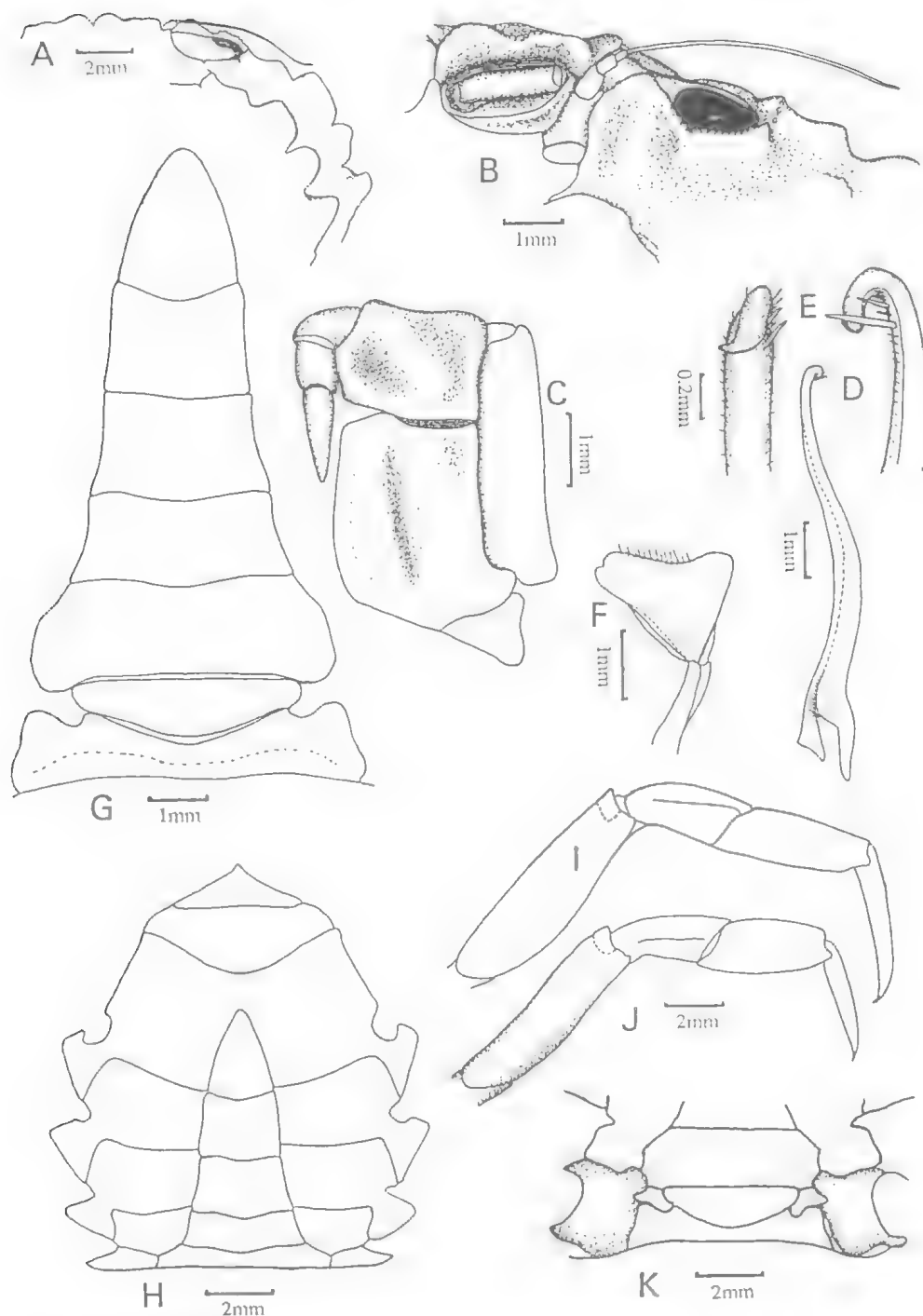


FIG. 8. *Benthopanope estuarius* sp. nov., A, G, holotype male, B-F, H-K, paratype male (QM W13196). A, outline of frontal and anterolateral border, and secondary outline of anterolateral border of male paratype; B, frontal view of orbit and antennal peduncle; C, third maxilliped; D, first pleopod; E, tip of first pleopod; F, endopod of first maxilliped; G, abdomen; H, sternum and male abdomen *in situ*; I, J, fourth and fifth legs respectively; K, first three segments of abdomen and coxae of last pair of legs, showing sternite eight visible laterally beside abdomen.



FIG. 9. *Benthopanope estuarius* sp. nov., holotype male. Scale in mm.

carapace breadth between the last anterolateral teeth.

Basal antennal joint sub-rectangular, inner distal angle clearly separated from the front; outer distal edge prolonged a short distance into the orbital hiatus; antennal flagellum with free access to the orbit. Third maxilliped with merus much smaller than ischium (c. 0.55 times length); merus a little broader than long (c. 1.3 times), slightly expanded at outer distal angle, and slightly concave on anterior margin; ischium with a deep slightly oblique longitudinal groove; surface of both segments granulate, with only a few scattered setae, inner margin of ischium with a row of longer bristles; exopod does not quite reach to anterior margin of merus, with large triangular subdistal tooth on inner margin.

Chelipeds unequal, robust. Major cheliped with merus short, trihedral, armed with strong, subdistal tooth on upper posterior margin; lower margin rounded, upper anterior and posterior margins granulate; carpus with a small blunt tooth medially on inner margin with a downwardly directed rounded crest proximal to it, otherwise with dorsal surface made uneven by about seven low granular elevations which almost become low carinae on the outer margin; palm swollen, relatively smooth, superior margin with poorly defined granulate crest proximally, rounded distally, length (including fixed finger), about 1.75 times height, fingers pointed, length of dactyl about 1.3 times length of superior margin of palm, fixed finger slightly deflexed armed with several large blunt teeth proximally, dactyl with comparatively much smaller rounded teeth proximally. Smaller cheliped of similar form but less robust and with the fingers more strongly deflexed. Dactyl (except for some darkening proximally) and the distal two thirds of the fixed finger, entirely white.

In smaller specimens the chelae are not always smooth, being variably granular, and sometimes with the granules covering the whole outer surface except for the area behind the gape, and the fingers, although the granules can extend in a line along most of the fixed finger.

Walking legs of moderate length, unarmed, second pair the longest; merus of third walking leg about 3.4 times as long as wide; dactyli about the same length as propodi and terminate in acute chitinous tips. Legs covered in a short tomentum, longer on propodus and dactylus.

Male abdomen relatively narrow: first segment the widest; second segment constricted; third segment nearly as wide as first, small median

concavity on lateral margins; fourth segment about the same length but much narrower; fifth and sixth segments progressively longer and narrower; telson very elongated and triangular (c. 1.4 times longer than broad at base). Sternite eight is clearly visible adjacent to the second segment of the abdomen. First male pleopod long, thin, and sinuous with the tip very thin and completely curled back on itself; several stout bristles at base of distal curve.

HABITAT

Estuarine sub-tidal muddy bottoms; shell grit, pebbles and silt bottom; under coral rubble on sandflat; under rocks on muddy sand; mudflat. Found in salinities from 13 p.p.t. to full seawater.

DISTRIBUTION

From Port Curtis, SE Queensland around northern Australia to Broome in the northwest.

REMARKS

B. estuarius sp. nov. is most closely allied to *B. sexangula* (Rathbun, 1909) and *B. eucratoides* (Stimpson, 1858). It is readily separable from these species because: the anterolateral margin is cut into five teeth rather than four (the crest behind the external orbital angle has developed a supplementary tooth); the second last anterolateral tooth is much longer, broader, and more prominent; the front is more prominent and sinuous; and there is a subhepatic tubercle developed.

Benthopanope sexangula (Rathbun, 1909) (Fig. 10A-H)

Heteropanope sexangula Rathbun, 1909, p. 114; 1910, p. 358, pl. 2, fig. 6, text. fig. 43.

Non *Heteropanope sexangula*: Rathbun, 1924, pp. 21-22 (= *B. estuarius* sp. nov.).

Pilumnopoeus sexangulus: Balss, 1933, pp. 33, 34; Takeda and Miyake, 1969, p. 120.

(?) *Pilumnopoeus eucratoides*: Balss, 1938, p. 59 (not *P. eucratoides* Stimpson, 1858).

MATERIAL EXAMINED

HOLOTYPE: ♀ (7.0 × 5.2 mm), Gulf of Siam, Th. Mortensen, in the collections of the Zoologisk Museum, University of Copenhagen, Denmark.

OTHER: QM W14827, ♂ (9.8 × 7.4 mm), end of Lim Chu Kang Rd, northwestern Singapore, in fouling on rocks, 6.ix.1987, P. Davie and P. Ng.

DESCRIPTION OF HOLOTYPE

Carapace wider than long (1.35 times), convex along the mid-line, flat from side to side across the

branchial regions but depressed laterally before the anterolateral teeth giving a plateau-like appearance. Regions moderately well indicated; transverse granular crests on frontal, epigastric and protogastric regions; a short oblique crest on the anterior branchial region, longitudinal crests laterally on the postero-branchial regions; gastro-cardiac and cervical grooves clearly indicated and the 3M and cardiac regions are defined. Dorsal surface microscopically granular. Frontal margin

moderately protruding, with slightly more prominent, small median lobes, bluntly rounded laterally; separated from the orbit by a strong shoulder. Supra-orbital margins with median and lateral vestigial fissures; finely granular; outer orbital angle strongly produced. Infra-orbital border without a strong lateral sulcus, being merely deeply angled; vestigial fissure is apparent; broad, bluntly rounded triangular lobe on inner half visible dorsally. Sub-hepatic and pterygosto-

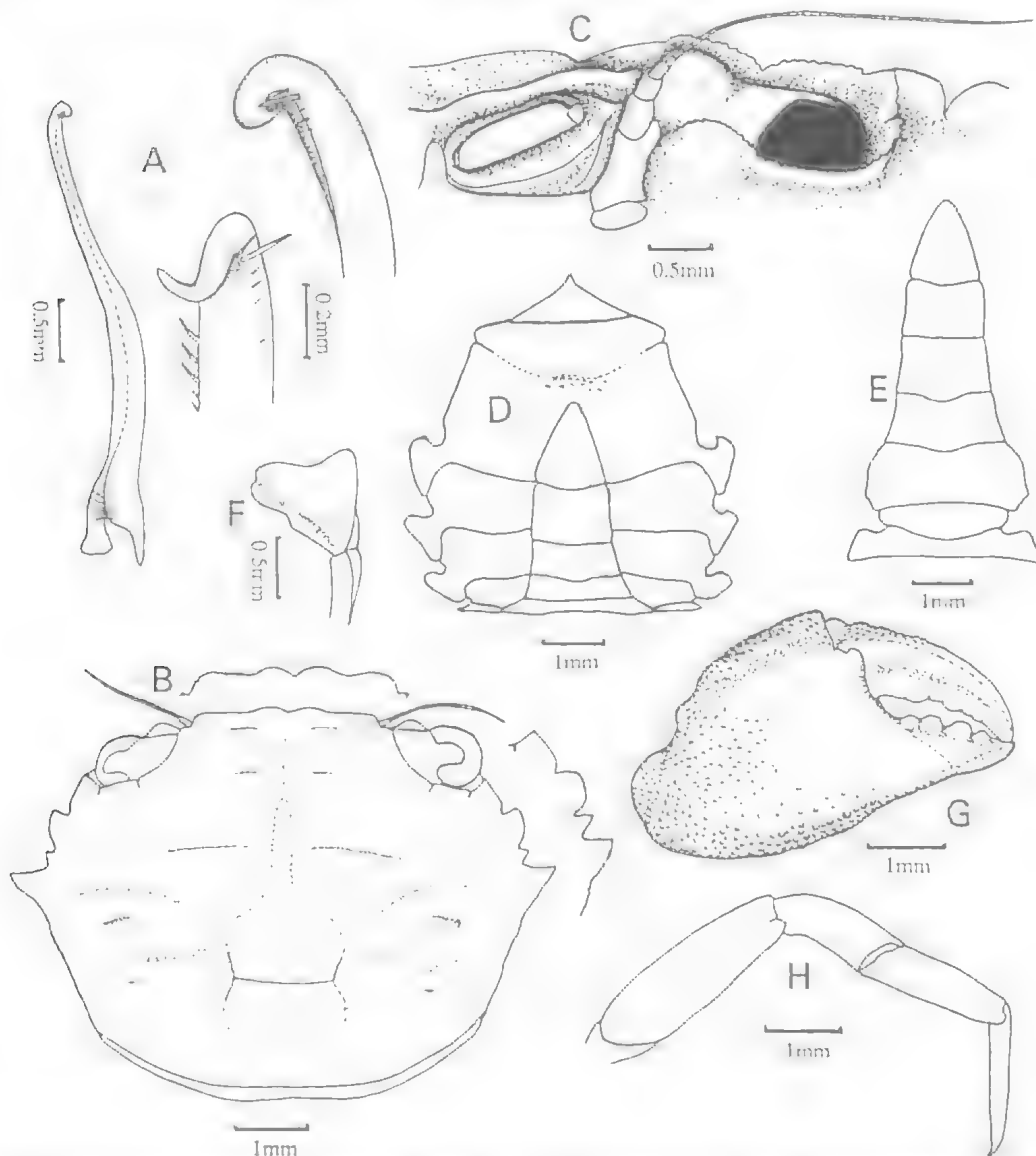


FIG. 10. *Benthopanope sexangula* (Rathbun, 1909). A, C-F of male (QM W14827) from Singapore; B, G, H, of holotype female. A, first pleopod; B, dorsal view of carapace, and secondary outline of front and right anterolateral border of male from Singapore; C, frontal view of orbit and antennal peduncle; D, sternum and abdomen in situ; E, male abdomen; F, endopod of first maxilliped; G, right chela; H, fourth leg (denuded).

mial regions granular and covered with short setae; longer feathered setae adjacent merus of chelipeds.

Anterolateral margins much shorter than posterolateral, divided into four teeth including the external orbital angle: the first and second are subequal in size, forwardly directed; the third is minute but clearly defined; the fourth, the longest, is a broad, acute, laterally directed spine, and is at a level slightly above the other three teeth.

Basal antennal joint sub-rectangular; inner distal angle clearly separated from the front; outer distal edge prolonged as a rounded lobe into the orbital hiatus; antennal flagellum with clear access to the orbit. Third maxilliped with merus much smaller than ischium (c. 0.55 times length); merus broader than long (c. 1.45 times), outer distal angle broadly rounded, anterior margin very slightly concave, almost straight; ischium with a deep slightly oblique longitudinal groove; exopod does not quite reach anterior margin of merus, with large triangular subdistal tooth on inner margin.

Chelipeds unequal, robust. Major cheliped with merus, short, trihedral, armed with strong, subdistal tooth on upper posterior margin; all margins granulate; carpus with a small blunt tooth medially on inner margin, upper surface with 6–7 small elevated granular patches; palm swollen,

distinctly granular along upper and lower margins, extending for about proximal half of fingers, and across proximal half of outer face, length (including fixed finger) about 1.75 times height, fingers pointed, length of dactyl about 1.6 times length of superior margin of palm, both fingers armed with 3–4 larger, bluntly rounded teeth. Smaller cheliped of similar form but less robust and a little more coarsely granular; cutting margins of fingers much sharper and more cristate. Fingers of the preserved specimen are not particularly darkened but may have been a pale brown in life.

Walking legs of moderate length, unarmed, second pair the longest; merus of third walking leg about 3.3 times as long as wide; dactylus a little longer than propodus and terminating in an acute chitinous tip. Legs fringed with short setae, longer on the margins of the propodi and dactyli.

HABITAT

In fouling on rocks and wood.

DISTRIBUTION

Gulf of Siam (Rathbun 1909); Singapore (present study).

REMARKS

It is possible that *B. sexangula* may prove to be

TABLE 1. Major differences between the larvae of *Heteropanope glabra*, *Pilumnopus serratifrons*, *Benthopanope indica* and *B. eucratoides*. Information from Greenwood and Fielder (1984a,b) and Lim, Ng and Tan (1984, 1986).

<i>Heteropanope glabra</i>	<ul style="list-style-type: none"> • Lateral carapace spines large • Rostrum large in all stages • Third abdominal segment with lateral papillae • Four zoeal stages
<i>Pilumnopus serratifrons</i>	<ul style="list-style-type: none"> • Lateral carapace spines relatively small • Rostrum is very tiny in the first zoea and shorter than antennal processes in later stages • Third abdominal segment with lateral papillae • Three zoeal stages
<i>Benthopanope indica</i>	<ul style="list-style-type: none"> • Lateral carapace spines lacking on at least the first zoea • Rostrum not evident • Third abdominal segment lacks lateral papillae • Number of zoeal stages not known
<i>Benthopanope eucratoides</i> (? = <i>B. sexangula</i>)	<ul style="list-style-type: none"> • Lateral carapace spines absent • Rostrum small • Third abdominal segment lacks lateral papillae • Three zoeal stages

a synonym of *B. eucratoides* Stimpson. Rathbun (1909, 1910) separated the two species on the following characters: *eucratoides* was described as having a smooth carpus on the cheliped, whereas *sexangula* has raised granular patches; *eucratoides* has smooth sub-hepatic and sub-branchial regions whereas in *sexangula* these are granular (in her 1924 paper Rathbun further said that *sexangula* had a sub-hepatic tubercle but this is not present on her type, and is true only of specimens of *B. estuarius* sp. nov. which she confused with *sexangula*); *eucratoides* has smooth chelae whereas on *sexangula* they are granular; in *eucratoides* the external orbital hiatus is obsolete whereas in *sexangula* it is defined.

The value of most of these characters is arguable although the first, the smooth versus granular carpus on the cheliped, does seem to be a strong character. The raised granular patches are clearly evident on the small type female and on the larger male from Singapore, and are present on all of the specimens of *B. estuarius*, so it does not appear to be a character subject to much variation. The degree of granulation of the chelipeds otherwise seems variable from smooth to quite coarse and is considered of little use. The male specimen from Singapore has a less clearly defined external orbital hiatus than the type, but this is a matter of degree only. The type material of *B. eucratoides* was apparently destroyed in the great Chicago fire of October 1871 (Manning, *in litt.*; Evans, 1967) and therefore fresh material needs to be collected from the type-locality (Hong Kong) and a neotype erected before the problem of the synonymy of *eucratoides* and *sexangula* can be resolved. Until that time it is advisable to maintain *B. sexangula* as a separate species.

LARVAL STUDIES

Larval descriptions exist for *Heteropanope glabra* (Greenwood and Fielder, 1984b; Lim, Ng and Tan, 1984); *Pilumnopus serratifrons* (Wear, 1968; Greenwood and Fielder, 1984a); *Benthopanope eucratoides* (? = *B. sexangula*) (Lim, Ng and Tan, 1986); and *Benthopanope indica* (Takeda and Miyake, 1968; ? Aikawa, 1929). Table 1 summarises the main points of difference between the larvae of these four species.

Although only a small number of species have been investigated there do appear to be differences between the three genera. For example, *Benthopanope* lacks lateral carapace spines, the rostrum is small or absent, and there are no lateral papillae on the third abdominal segment. *Pilumnopus*

serratifrons has, in common with *Benthopanope* species, only three zoeal stages, but on the contrary has a pair of lateral papillae on the third abdominal segment, a character shared with *Heteropanope glabra*. *Heteropanope* differs from the other two genera by having four zoeal stages, a large rostrum and large lateral carapace spines. The investigation of additional species is necessary before these conclusions can be properly validated.

GONEPLACIDAE Dana, 1852

Flindersoplax gen. nov.

DIAGNOSIS

Carapace markedly broader than long, flat or slightly convex posteriorly, moderately convex anteriorly; regions very poorly defined. Antero-lateral margins cut into four blunt teeth, the first tooth commencing behind the unarmed outer-orbital margin. Front produced, bilobed, separated laterally from orbits by small rounded sinuses. Antenna lies in the orbit, basal antennal segment just touches the front at the inner edge and is produced into the orbital hiatus at the outer edge. Third maxillipeds close the buccal cavity; merus wider than long and about half the length of the ischium. Chelipeds unequal, stout, with bluntly pointed fingers; major chela particularly, armed distally with a large, backwardly directed molariform tooth. Legs of moderate length, the second pair about twice the length of the carapace. Male abdomen broad, of seven free segments, and completely covering sternum between coxae of fifth walking legs. Sternal plastron relatively wide. First male pleopod relatively straight, stout, bluntly pointed, little ornamented. Second male pleopod about a half the length of first, with a short recurved tip.

ETYMOLOGY

Named in honour of Mathew Flinders for his exploration of the Australian coast and after the biogeographic region already named for him and in which it was found. This is combined with the Greek, *plax*, meaning broad and flat. Gender is feminine.

Flindersoplax vincentiana (Rathbun, 1929) (Figs 11, 12)

Heteropanope vincentiana Rathbun, 1929, pp. 37–38, Pl. IV.

MATERIAL EXAMINED

NEOTYPE: USNM 62042, ♂ (24.2 × 15.7 mm), Port Willunga, Gulf St. Vincent, South Australia, Feb. 1895, W.J. Kimber. (Dry specimen restored to spirit with ethylene glycol in 1967).

TYPE STATUS

The female holotype of *Heteropanope vincetiana* Rathbun is apparently no longer extant as searches conducted at the author's request have failed to locate it at either the South Australian

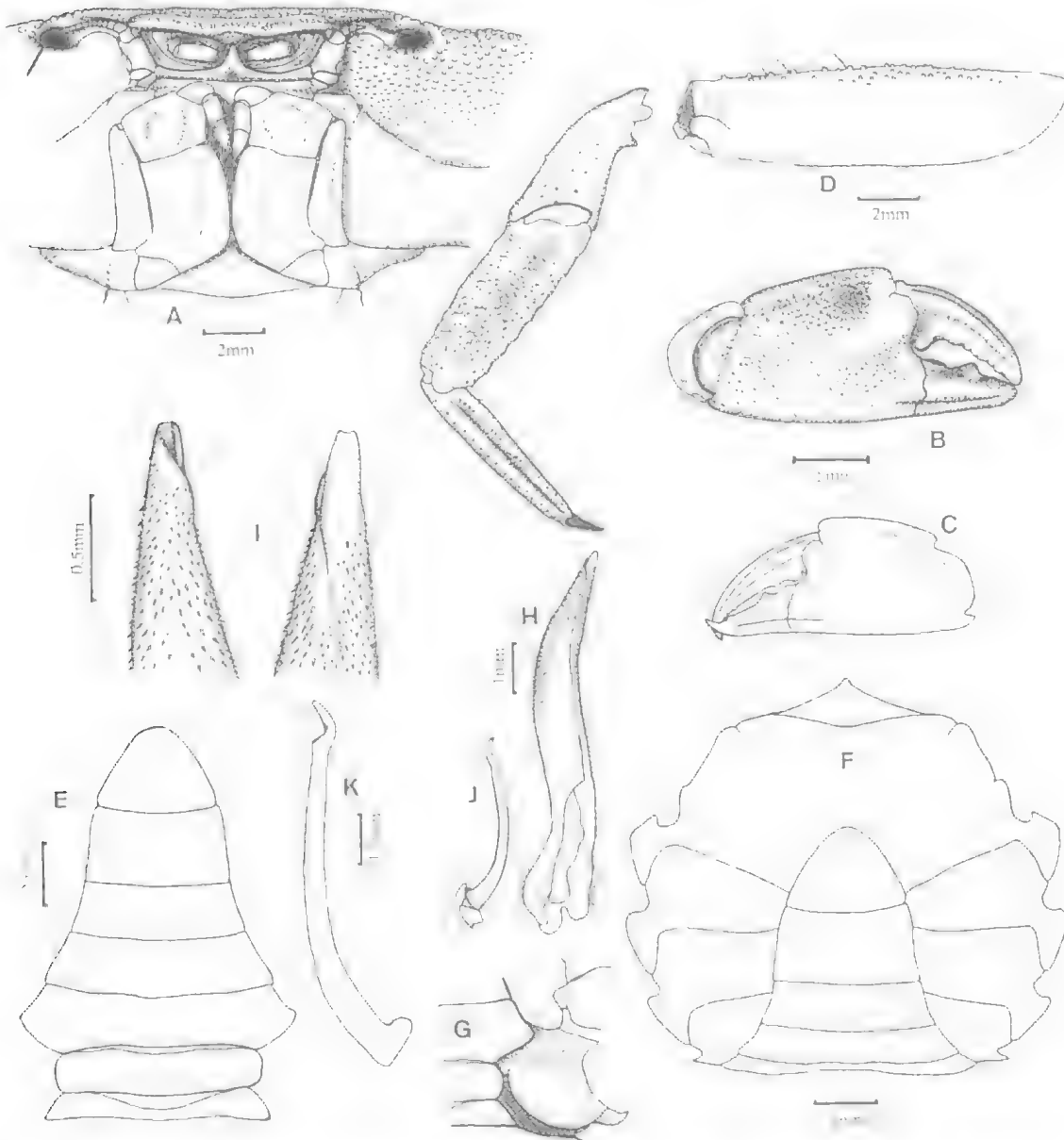


FIG. 11. *Flindersoplax vincentiana* (Rathbun) neotype male: A. frontal view showing maxillipeds and antennal and antennular regions; B. right chela; C. left chela; D. third left walking leg; E. abdomen; F. sternal plastron and abdomen; G. configuration of abdominal segments 1, 2, and 3 and coxa of fifth walking leg; H. first pleopod; I. magnifications of tip of first pleopod; J, K. second pleopod.

Museum or the United States National Museum (Drs W. Ziedler and R. Manning, *in litt.*). Therefore I designate the male paratype (USNM 62042) as the neotype. This specimen was collected from the type locality.

DESCRIPTION

Carapace 1.54 times broader than long, broadest at level of last anterolateral tooth. Anterolateral margins shorter than posterolateral, cut into four blunt teeth; no tooth present at the outer orbital margin, the first anterolateral tooth is well separated from the orbit and is a broad, low, blunt lobe; the second and third teeth are subequal and subacute, the fourth tooth is much smaller and also sub-acute. Front deflexed, with oblique lateral borders in dorsal view, but with a strong median convexity; a narrow shallow furrow, backed by a line of close set granules, runs parallel and just posterior to the margin; separated laterally from inner superior border of orbit by a small rounded sinus.

Orbital cup rounded, inner superior margin smooth becoming coarsely granular laterally and

on to outer half of lower margin; inner part of lower border produced into a broad blunt lobe.

Dorsal surface of carapace nearly flat in its posterior half but becoming noticeably convex anteriorly. Regions are poorly defined except for the narrow, anterior part of the mesogastric, with a small furrow anterior to it; a faint gastro-cardiac groove; and faint epibranchial grooves. Across the front, from about the level of the second anterolateral teeth and behind the orbit, is an irregular broad transverse furrow. The whole anterior half is strongly granulate, being coarsest laterally behind the orbits and first and second anterolateral teeth, becoming smaller posteriorly and medially. For most of the posterior half the surface is smooth and punctate. Subhepatic regions also coarsely granular, but becoming smooth lower down on the pterygostomian.

Basal antennal article quadrate, just touching the front at its inner edge, outer margin produced and entering the orbit a little way; antennal flagellum lies within the orbital hiatus, and extends a little beyond the orbit laterally. The ridges defining the efferent branchial channels are strong



FIG. 12. *Flindersoplax vincentiana* (Rathbun) neotype male, USNM 62042. Scale in mm.

and extend to the margin of the epistome. The third maxillipeds completely close the buccal cavity; exognath reaches to the outer angle of the Merus and has a strong subdistal triangular tooth on the inner margin which is normally hidden beneath the merus; merus wider than long and about half the length of the ischium, finely granular; ischium about 1.5 times longer than wide, smooth and punctate.

Chelipeds stout, unequal, the right the larger in the Lectotype; merus of major cheliped separated from basis-ischium, trihedral, nearly as broad as its greatest length; lower border rounded; superior, anterior, and posterior borders defined and granulate; carpus heavy, a little longer than wide, with a strong triangular tooth on the inner margin just posterior to the middle; palm swollen, length, including fixed finger, about twice height, upper half distinctly but minutely granulate and eroded, lower half smoother and more punctate; dactyl slightly longer than superior margin of palm, curved with a large distal backwardly directed molariform tooth, otherwise only minutely toothed; immovable finger with small medial triangular tooth; fingers brown in preserved specimen; both fingers grooved for most of their length. Smaller cheliped of similar form but more slender; fingers without gape, with sharper cutting margins, and each finger with two alternating proximal teeth, one of these the proximal molar of the dactyl is much less pronounced than on the larger cheliped.

Legs of moderate length, the second pair the longest and about twice as long as carapace; quite narrow, the merus of the third leg about 3.4 times longer than wide, although the fourth leg much wider than the others; meri with irregular coarse tubercles along upper margins and finer granulation on lower borders, particularly on the anterior legs (Rathbun (1929) describes a row of short blunt spines above, which are no longer evident); carpi, propodi, and dactyli with rough uneven surfaces (according to Rathbun (1929) the articulation sockets are provided with long hairs — these are no longer evident, although the surfaces appear to have follicular structures which suggest they were originally clothed with strong setae); dactyli nearly straight, with deep furrows on each side, and terminating with slender, bent, horny tips.

The male abdomen is rather broad, and consists of seven free segments; third segment the widest, with bluntly triangular margins; first segment narrow and slightly wider than second; second about 5 times wider than long; segments 3 to 5 tapering and of similar length; sixth segment much

longer being only twice as wide as long; telson the longest segment, bluntly rounded. The abdomen completely covers the sternum between the fifth pair of legs such that sternite eight is not visible. Sternal plastron comparatively wide.

The first male pleopod stout, only slightly sinuous, with bluntly pointed simple apex, and with a good covering of minute spinules on most of the distal half. Second male pleopod almost half the length of the first, curved, ending in a short recurved tip, unarmed except for a few microscopic hairs on the rim at the base of the recurved tip.

DISTRIBUTION

Only known from the type locality in Gulf St Vincent, South Australia.

HABITAT

No habitat information is available although it can be assumed to be a shallow subtidal species. If it occurred intertidally it would almost certainly have been re-collected subsequently. A preliminary search of the collections of Xanthoidea from the South Australian Museum have failed to reveal any more specimens.

REMARKS

Although this species is xanthoid at first appearance it cannot belong to that superfamily as it is presently defined. The shapes of the first and second male pleopods are striking features of *Flindersoplax* and are important characters when looking for related groups. Those groups that must be considered are:

1. The Pilumnoidinae Guinot and Macpherson, 1987. This new subfamily of the Xanthidae is characterised by: carapace rounded, much wider than long; sternal plastron long and narrow with the sutures 4/5 and 7/8 complete and subparallel; the presence of a 'press-stud' locking mechanism for the abdomen; the male genital orifice coxal, without sternite eight being visible; abdomen of male composed of seven distinct segments; endostomial crests complete; ischium and merus of chelipeds fused; first male pleopod nearly straight, with the apex having little ornamentation; second male pleopod neither very short nor sigmoid, and with the peduncle well developed and terminating in a short flagellum. Factors against placing *Flindersoplax* in this subfamily are that the sternum is broad and not of the typical narrow form as figured by Guinot and Macpherson (1987, fig. 1) and on the cheliped, the ischium is clearly separated from the merus.

2. *Pseudozius*: this genus is also currently difficult to place in the existing family structure. It is very close to the Menippidae but is generally excluded because of the comparatively very small second male pleopod. This pleopod is of the same type as *Flindersoplax* although in *Flindersoplax* it is much longer. *Pseudozius* has a slightly wider sternal plate than is typical in the Menippidae but nevertheless is very similar to members of that family by the shape of the relatively narrow male abdomen, and the proportions of the segments, which in the author's experience are quite similar throughout all the genera of that family. In *Flindersoplax*, as in *Pseudozius* and the members of the Menippidae, sternite 8 is completely hidden below the abdomen laterally, but *Flindersoplax* has a relatively much broader, oval, sternal plate and also has an exceptionally wide abdomen.

3. The genus *Platycheilonion* Crosnier and Guinot, 1969. The West African species *P. planissimum* Crosnier and Guinot, 1969, is the only representative. The systematic position of this genus is uncertain. The fact that sternite 8 is left exposed laterally between the abdomen and the fifth leg suggests relationships with the Goneplacidae, and as well with *Neopilumnoplax* with which it shows other superficial likenesses. The second male pleopod of *Neopilumnoplax* (see Guinot, 1969, figs 84, 89) is however very much longer and it is equipped with a long flagellum. This suggests that its relationship is not very close with either *Platycheilonion* or *Flindersoplax*. The sternite 8 of *Flindersoplax* is not exposed laterally and this contradicts a close relationship with *Platycheilonion* although there are many other similarities, notably very similar male pleopods, abdomen shapes, and carapace shape.

4. The Geryonidae: the status of this family is uncertain (see Manning and Holthuis, 1981). Guinot (1971) questionably attributed *Platycheilonion* to this family without arguing her position although Crosnier and Guinot (1969) originally felt it to be most closely related to the Carcinoplaceinae-Goneplacinae. *Flindersoplax* shows no marked resemblance to any of the central genera of the Geryonidae (*Geryon*, *Progeron*, *Platypilumnus*) in the overall shape, or in the configurations of the front, antennular, or antennal regions, or of the sternal plate. It does show some superficial resemblance to *Paragalene longicrura* (Nardo) but cannot be closely related as that species has the male abdominal segments 3 and 4 fused, and the flagellum of the second male pleopod bears spinules towards its apex which is also peculiar. Most authors seem in agreement that

Paragalene is misplaced in the Geryonidae (Guinot, 1969; Manning and Holthuis, 1981).

5. Carcinoplaceine and goneplacine Goneplacidae (*sensu* Guinot, 1971). In the shape of the sternal plate, and in the male abdomen, *Flindersoplax* is very close to genera such as *Carcinoplax*, *Neopilumnoplax*, *Mathildella* and *Beuroisia*. The two characters which make placement here difficult are: a, sternite 8 is not visible laterally beside the abdomen; and b, the second male pleopod is much shorter than any species so far attributed to this group. With regard to the first, *Beuroisia* species have sternite 8 completely covered by the male abdomen and some species of *Carcinoplax* have the visible lateral portion of sternite 8 much reduced (c.f. *C. cooki* (Rathbun)). Secondly it could be considered that it is mainly the flagellum of the second male pleopod that is so dramatically reduced and that this could be a derived character which would not necessarily remove it far from the other genera of the Carcinoplaceinae-Goneplacinae. *F. vincentiana* cannot be assigned to *Beuroisia* as the sternal plastron is comparatively wider; the configuration of the antennae and antennules is quite different (c.f. Fig. 1a in this paper with Fig. 6B,C in Guinot and Richer de Forges (1981)) and the second male pleopod is so much shorter.

It is impossible to confidently place *Flindersoplax* into the existing systematic structure. A complete re-evaluation of the relationships of the genera described above is urgently needed. Nevertheless I consider the configuration of the broad, oval sternum and the wide abdomen to be of major importance in determining its closest relatives, and on this basis I place it tentatively within the Carcinoplaceinae of the Goneplacidae.

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Carlos Picasso printed them. Phil Lawless is thanked for help in searching for literature, compiling synonymies and for useful discussions on the manuscript. Mrs Peta Woodgate, as usual, has done an excellent job in converting the MS into typeface. This work was funded by a grant from the Australian Biological Resource Study.

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DEEPWATER BRACHYURA (CRUSTACEA: DECAPODA) FROM SOUTHERN QUEENSLAND, AUSTRALIA WITH DESCRIPTIONS OF FOUR NEW SPECIES

P.J.F. DAVIE AND J.W. SHORT

Davie, P.J.F. and Short, J.W. 1989 11 13: Deepwater Brachyura (Crustacea: Decapoda) from southern Queensland, Australia with descriptions of four new species. *Mem. Qd Mus.* 27(2): 157-187. Brisbane. ISSN 0079-8835.

Twenty-eight species of deepwater crabs are recorded from mid-and southeastern Queensland taking the number now known to 33. Nine species have not previously been recorded from Australia, viz *Dicranodromia baffini* Alcock and Anderson, *Latreillopsis bispinosa* Henderson, *Paromola japonica* Parisi, *Paromolopsis bousi* Wood-Mason, *Notopoides latus* Henderson, *Cyrtomaia horrida* Rathbun, *Pleistacantha oryx* Ortmann, *Benthochascon hemingi* Alcock and Anderson, *Intesius pilosus* Guinot and Richer de Forges. Four new species are described. *Ranilia tenuiocellus* sp. nov. resembles *R. horikoshi* Takeda in having degenerated eyes but differs in the lack of orbital teeth. *Ranilia trirufomaculata* sp. nov. is described from Western Australia and Queensland. It is distinguished from *R. misakiensis* Sakai by the three dorsal red spots, the sharp distal spine on the superior border of the palm, the lack of a raised ridge on the wrist, and carapace proportions. A key to Indo-west Pacific *Ranilia* H. Milne Edwards species is given. *Mursia microspina* sp. nov. differs from its closest congener *M. hawaiiensis* Rathbun by having shorter postero-lateral borders, a smaller length to breadth ratio, and by the shape of the tubercles on the lower inferior border of the chela. *Rochinia griffini* sp. nov. is unique in the disposition and length of the carapace spines. *Carcinonectes pacificus* Stephenson is synonymised with *Benthochascon hemingi* Alcock and Anderson.

□Crustacea, Brachyura, Australia, new records, new species, Homolodromiidae, Dromiidae, Homolidae, Raninidae, Calappidae, Leucosiidae, Majidae, Portunidae, Geryonidae, Goneplacidae

P.J.F. Davie and J.W. Short, Queensland Museum, PO Box 300, South Brisbane, Queensland 4101, Australia; 10 April, 1988.

Collections of deepwater crustacea from Queensland have been few. Campbell (1971) reported on collections made by the trawler *Nimbus* off southern Queensland, and this appears to be the first account of any deepwater species. The *Nimbus* survey however, was not specifically deepwater and although some shots were made as deep as 204 fm (373 m), most were in quite shallow water. Only five stations were from depths of 100 fm (183 m) or more, and from these only seven species were recorded. The F.I.S. *Endeavour* undertook exploratory offshore dredging and trawling but deepwater work seems to have been confined to southern Australia (see Rathbun, 1923). The work of most direct relevance was that done on collections made by the crew of the *Kapala* and reported on by Griffin and Brown (1976). They found fourteen species of crab from deep water off the coast of New South Wales.

Between 1980 and 1984 the Queensland Fisheries Service undertook a number of exploratory cruises to investigate the potential of fish and crustacean fisheries in the deeper waters of the lower continental shelf and slope. All trawls were using Siebenhausen prawn nets, so in general the smaller faunal components were not brought to the surface.

The first expedition was the *Craigmin* survey. This was conducted between 21°30'S and 26°31'S in September-October 1980. This was a combined Queensland and Commonwealth Government survey but unfortunately much of the material was poorly preserved. The next survey was aboard the *Iron Summer* between July 1982 and June 1983 (see Potter, 1984). This covered the area between 26°20'S and 28°10'S (i.e. between Noosa and Point Danger, SEQ). The *Southern Intruder* operated out of Bundaberg between August 1983 and April 1984 (see Dredge and Gardiner, 1984) sampling the Saumarez Plateau (22°-24°30'S) in depths between 150 m and 750 m. This was in many ways a resample of the earlier *Craigmin* survey.

This paper reports on these recent collections and summarises the deepwater brachyuran crab fauna currently known from southern Queensland. As there is a further paper projected on collections from deep water off northern Queensland, discussion on biogeographic aspects will be reserved for that paper. The material has been collected largely by the Queensland Fisheries Service (Q.F.S.). The bulk of the material is housed at the Queensland Museum (QM) although some material in the collections of the Australian

Museum, Sydney (AM) has also been examined. Synonomies are not necessarily complete. Measurements are given as carapace length (cl.) or width (cw.), but unless otherwise stated, measurements are of carapace width. All drawings were made with the aid of a camera lucida.

SPECIES LIST OF DEEPWATER
BRACHYURA TRAWLED OFF SOUTHEAST
AND MID-EASTERN QUEENSLAND

* Denotes species reported by Campbell (1971) from SEQ and not found during the present study.

Section PODOTREMATA

Family HOMOLODROMIIDAE

Dicranodromia baffini (Alcock and Anderson, 1899)

Family DROMIIDAE

Petalomera wilsoni (Fulton and Grant, 1902)
* *Cryptodromia areolata* Ihle, 1913

Family HOMOLIDAE

Homola orientalis Henderson, 1888
Homolochunia kullar Griffin and Brown, 1976
Latreillopsis bispinosa Henderson, 1888
Latreillopsis petterdi Grant, 1905
Paromola japonica Parisi, 1915
Paromolopsis boasi Wood-Mason, 1891

Family RANINIDAE

Notopoides latus Henderson, 1888
Ranilia tenuiocellus sp. nov.
Ranilia trirufomaculata sp. nov.

Section HETEROTREMATA

Family CALAPPIDAE

Mursia microspina sp. nov.

Family LEUCOSIIDAE

Arcania undecemspinosa de Haan, 1841
* *Ebalia brevimana* Campbell, 1971
* *Ebalia longimana* Ortmann, 1892
* *Merocryptus lambriformis* A. Milne Edwards, 1873
* *Cryptocnemus hemispheroides* Campbell, 1971

Family MAJIDAE

Cyrtomaia horrida Rathbun, 1916
Cyrtomaia suhmii Miers, 1886
Leptomithrax waitei (Whitelegge, 1900)
Platymaia fimbriata Rathbun, 1916

Platymaia maoria Dell, 1963
Platymaia remifera Rathbun, 1916
Pleistacantha orxy Ortmann, 1893
Rochinia griffini sp. nov.

Family PORTUNIDAE

Benthochascon hemingi Alcock and Anderson, 1899
Charybdis (Charybdis) miles (de Haan, 1835)
Charybdis (Gonioneptunus) bimaculata (Miers, 1886)
Ovalipes molleri (Ward, 1933)
Parathranites orientalis Miers, 1886

Family GERYONIDAE

Geryon affinis A. Milne Edwards and Bouvier, 1894

Family GONEPLACIDAE

Intesius pilosus Guinot and Richer de Forges, 1981

Family HOMOLODROMIIDAE

Dicranodromia baffini (Alcock and Anderson, 1899)

Arachnodromia Baffini Alcock and Anderson, 1899, pp.7,8; Alcock, 1899a, p.19, pl.2, figs 1, 1a-c; 1899b, p.132; 1901, p.33, pl.1, figs 1, 1a-c.
Dicranodromia baffini: Ihle, 1913, pp.86,89; Gordon, 1950, pp.204-5, text-figs 1A, 1B.

MATERIAL EXAMINED

QM W10801, ♂ (16.3 mm), trawled M.V. 'Iron-Summer', 27°59.37'S, 154°00.12'E, 590 m, 31.iii.1983, R. Morton (Q.F.S.).

REMARKS

Only two species of *Dicranodromia* have been reported from the Indo-West Pacific — *D. baffini* (Alcock and Anderson, 1899) and *D. doderleini* (Ortmann, 1892). These species are apparently closely related and it seems that characters for their separation are still poorly defined. *D. doderleini* has been considered endemic to Japan, although Serène and Vadon (1981) have recorded it from the Philippines without commenting on the features which distinguish their specimens from *D. baffini*.

Our specimen agrees with Alcock and Anderson's (1899) description of *D. baffini* in most respects. On the hepatic regions are a few spinules which are distinctly shown in the figures of Alcock

(1899a, pl.1, fig.1; 1901, pl.1, fig. 1), but Sakai (1976) remarks that the hepatic regions of *D. baffini* are unarmed, and conversely that *D. doderleini* has a few spinules in this region. Sakai (1976) also claims that the posterior carapace border is straight in *D. baffini* but invaginated in *D. doderleini* — it is clearly invaginated on our specimen and in the figure of *D. baffini* provided by Alcock (1899a, pl.1, fig.1). This character is probably of dubious status.

The outer surface of the palm of the chelipeds is uniformly covered with tubercles as Sakai describes for *D. baffini* and the length to breadth ratio of the telson is very close to that figured by Alcock (1901, pl.1, fig. 1b). Sakai (1976) states that the telson of *D. doderleini* is distinctly more elongate.

Points of difference with the original description are: the flagellum of antenna is about equal to the length of carapace (excluding rostral spines), not longer than the carapace; and the first leg (only one is intact) is less than twice the length of the carapace (c. 1.7 ×).

We feel that there is still some confusion in published accounts of these two species. However our specimen is closer to *D. baffini* than to *D. doderleini* and in our opinion the differences noted — considering the small amount of material which has apparently been reported on — are insufficient grounds for describing our specimen as new.

DISTRIBUTION

Andamans, Travancore Coast, Maldives, and southeast Queensland, Australia.

Family DROMIIDAE

Petalomera wilsoni (Fulton and Grant, 1902)

Cryptodromia wilsoni Fulton and Grant, 1902, p.61, pl.9.

Cryptodromia lateralis: Chilton, 1911, pl.29 (not of Gray).

Dromia pseudogibbosa Parisi, 1915, p.102, pl.2, figs 1,2; Balss, 1922, p.106; Yokoya, 1933, p.97.

Petalomera lateralis: Richardson, 1949, p.60, fig. 61 (not of Gray).

Petalomera wilsoni: Rathbun, 1923, p.154, pl.42, fig. 1; Hale, 1927, pp.111 (key), 113–4, fig. 111; Sakai, 1935, p.33, pl.1, fig. 3; 1936, p.34, pl.1, fig. 4, text-fig. 9; 1965, p.9, pl.4, fig. 2; 1976, p.24–5, pl.6, fig. 1; Dell, 1968, p.14, pl.2.

MATERIAL EXAMINED

QM W10744, ♀ ovig. (23.8 mm), trawled M.V. 'Iron

Summer', 27°24'S, 153°51'E, 2260m, 25.ix.1982, G. Smith (Q.F.S.).

DISTRIBUTION

Japan, New Zealand and within Australia from southeast Queensland to South Australia and Tasmania.

Family HOMOLIDAE

Homola orientalis Henderson, 1888

(Fig. 1A)

Homola orientalis Henderson, 1888, p.19, pl.2, fig. 1, 1a; Rathbun, 1923, pp.143–4, pl.37; Sakai, 1936, pp.46–7, pl.9, fig. 1; 1976, p.39, pl.8, fig. 4; Campbell, 1971, p.30; Serène and Lohavanijaya, 1973, p.24 (key), figs 19–22, pl.3A,B; Yaldwyn and Dawson, 1976, pp. 92–94, fig. 1.

Homola andamanica Alcock, 1899a, p.7; 1901, p.61, pl.4, fig. 20.

Homola barbata orientalis: Dolléin, 1904, pp.14–15 (in part).

Thelxiope orientalis: Sakai, 1965, p.15, pl.6, figs 3,4.

? *Homola orientalis*: Guinot and Richer de Forges, 1981a, pp.530–2, text-figs 1A, A1, B, B1, 2B, B1, C, C1, pl.1, figs 2, 2a, 3, 3a, 4, 4a.

MATERIAL EXAMINED

QM W10593, ♀ (13.7 mm), trawled M.V. 'Iron Summer', 27°24'S, 153°51'E, 260 m, 25.ix.1982, G. Smith (Q.F.S.); QM W10594, ♀ ovig. (18.7 mm), trawled M.V. 'Iron Summer', 27°44'S, 153°52'E, 220 m (Est.), 30.vii.1982, P. Dutton (Q.F.S.); QM W11234, ♂ (23.9 mm), ♀ ovig. (13.1 mm), trawled M.V. 'Southern Intruder', 23°33'S, 152°23'E, 240 m, 30.xi.1983, P. Davie.

REMARKS

Guinot and Richer de Forges (1981a) distinguished two forms of *Homola orientalis*, a 'Pacific' and an 'Indian Ocean' form. The principle differences they described were — the proportions of the cephalothorax, the form of the merus of ambulatory legs 2–4, and the relative number of spinules on the sub-hepatic area. However the specimens we examined showed a considerable amount of variation in the above characters, especially in the spinules of the sub-hepatic area which typically varied from 8–12 and on one specimen from 5–14 on opposite sides. Further, the subhepatic regions were usually obviously defined as in Guinot and Richer de Forges' (1981a) figure for the 'Indian Ocean' form (fig. 1 B1).

The carapace length to breadth ratio varied in

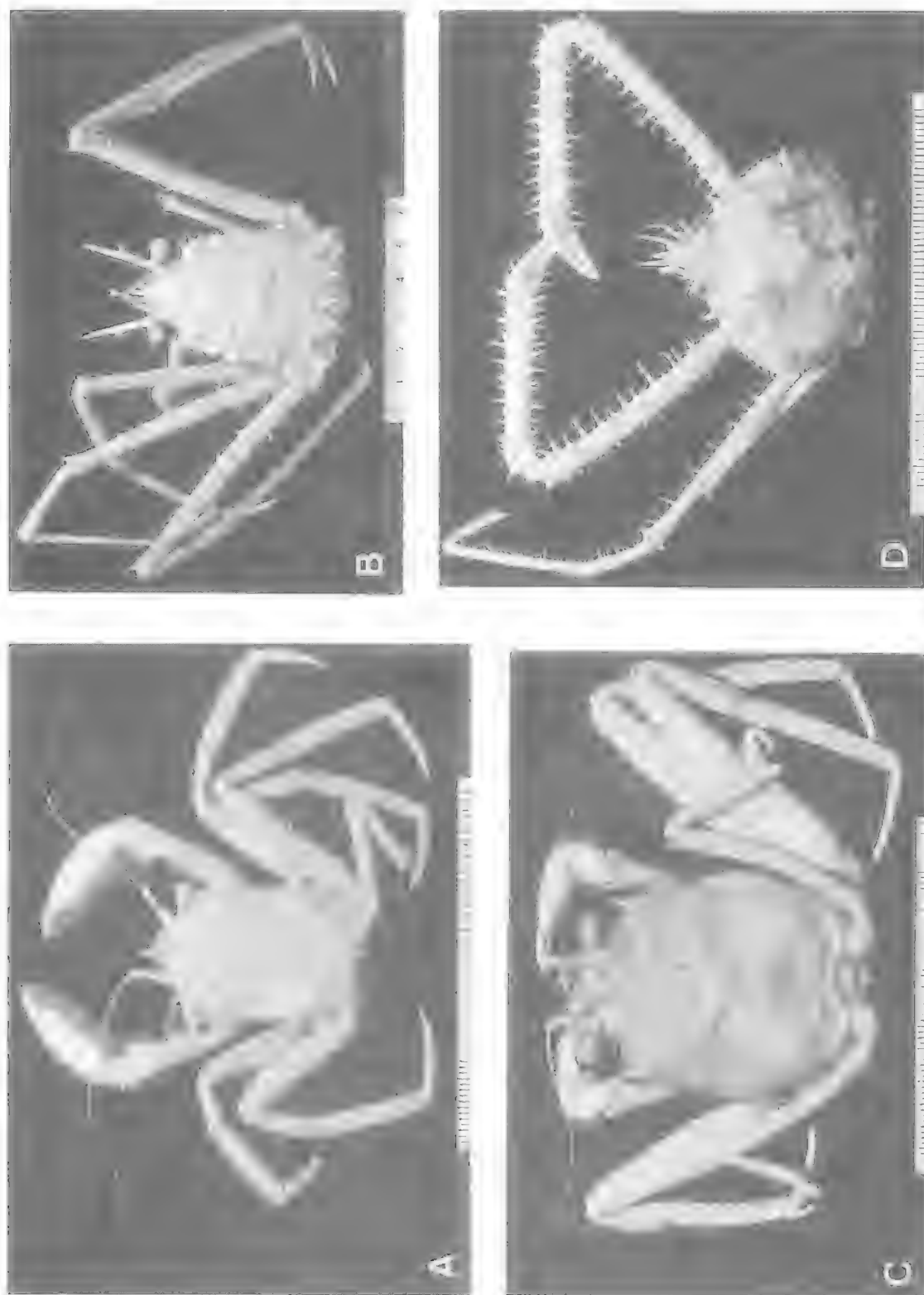


FIG. 1. A, *Homola orientalis* Henderson, 1888, ♂, QM W11234; B, *Latreillopsis petterdi* Grant, 1904, ♂, QM W10584; C, *Cyrtomaia horrida* Rathbun, 1916, ♂, QM W11225; D, *Paramolopsis boasi* Wood-Mason, 1891, ♂, QM W11228. Scale divisions 1 mm.

our specimens from 1.21 to 1.29 with an average of 1.25. Using the measurements given by Guinot and Richer de Forges (1981a) for their Pacific forms this range is extended to 1.14–1.29 with a mean of 1.22 ($n = 19$). The Indian Ocean form according to their measurements is generally of a smaller ratio, its range being 1.04–1.22 with a mean of 1.16 ($n = 22$). The ratios overlap markedly and therefore this character cannot be used with any certainty, although a tendency towards a more quadrate form is apparent in their Madagascar specimens.

DISTRIBUTION

Eastern Africa, Madagascar, Reunion Is., the Andamans, Indonesia, Japan, eastern Australia, New Zealand, New Caledonia and the Loyalty Isles.

Homolochunia kullar Griffin and Brown, 1976 (Fig. 3B)

Homolochunia kullar Griffin and Brown, 1976, pp.249–50, figs 1–3; Guinot and Richer de Forges, 1981a, fig. 4M.

MATERIAL EXAMINED

QM W10595, ♀ ovig. (29.6 mm), trawled M.V. 'Iron Summer', 27°53.90'S, 154°00.33'E, 560 m, 30.iii.1983, R. Morton (Q.F.S.); QM W14913, ♀ ovig. (27.6 mm), trawled M.V. 'Iron Summer', 27°13.00'S, 153°52.53'E, 590 m, 9.v.1983; R. Morton (Q.F.S.).

DISTRIBUTION

Off southeast Queensland and central New South Wales, Australia; New Caledonia.

Latreilopsis bispinosa Henderson, 1886 (Figs 2a–b, 3A)

Latreilopsis bispinosa Henderson, 1888, p. 22, fig. 3; Alcock, 1899b, p. 166; 1901, p. 73, pl. 7, fig. 26; Ihle, 1913, p. 77; Balss, 1922, p. 115; Yokoya, 1933, p. 103; Sakai, 1936, p. 53, pl. 2, fig. 2; 1965a, p. 16, pl. 7, fig. 2; Barnard, 1950, p. 343, fig. 65g; Gordon, 1950, p. 244, fig. 22a; Serène and Lohavanijaya, 1973, pp. 31–2, figs 47–50, pl. 4B.

MATERIAL EXAMINED

QM W10804, ♂ (12.5 mm), trawled M.V. 'Iron Summer', 27°35'S, 153°50'E, 210 m, 15.xii.82, G. Smith (Q.F.S.).

REMARKS

Our specimen is considered conspecific with *L.*



FIG. 2. *Latreilopsis bispinosa* Henderson, 1888, ♂, QM W10804; a — first male pleopod, abdominal view; b — second male pleopod, abdominal view; *Paramola japonica* Parisi, 1915, ♂, QM W10710; c — first male pleopod, abdominal view; d — sternal view of same (setae not shown); e — second male pleopod, abdominal view.

bispinosa Henderson, 1886, although there are some similarities with the very closely allied species *L. gracilipes* Guinot and Richer de Forges, 1981.

The characters which agree with *L. bispinosa* are:

1. There is an hepatic and sub-hepatic spine — the hepatic being longer and directed obliquely, and the sub-hepatic directed forwards. In *L. gracilipes* the two spines are of equal length and both are directed obliquely — there is also apparently a third, shorter spine below the line of the upper two and directed forwards.

2. Dorsal carapace surface lobulated but without spines (except for lateral branchials). *L. gracilipes* possesses a protogastric spine, a few spines on the cervical groove, and a small spine slightly below the homolian line halfway to the posterior margin.

3. Frontal region with three long acute spines, the median or rostral spine is directed forwards, and the two supraorbital spines placed at an angle of about 45° with the rostrum. The rostral spine

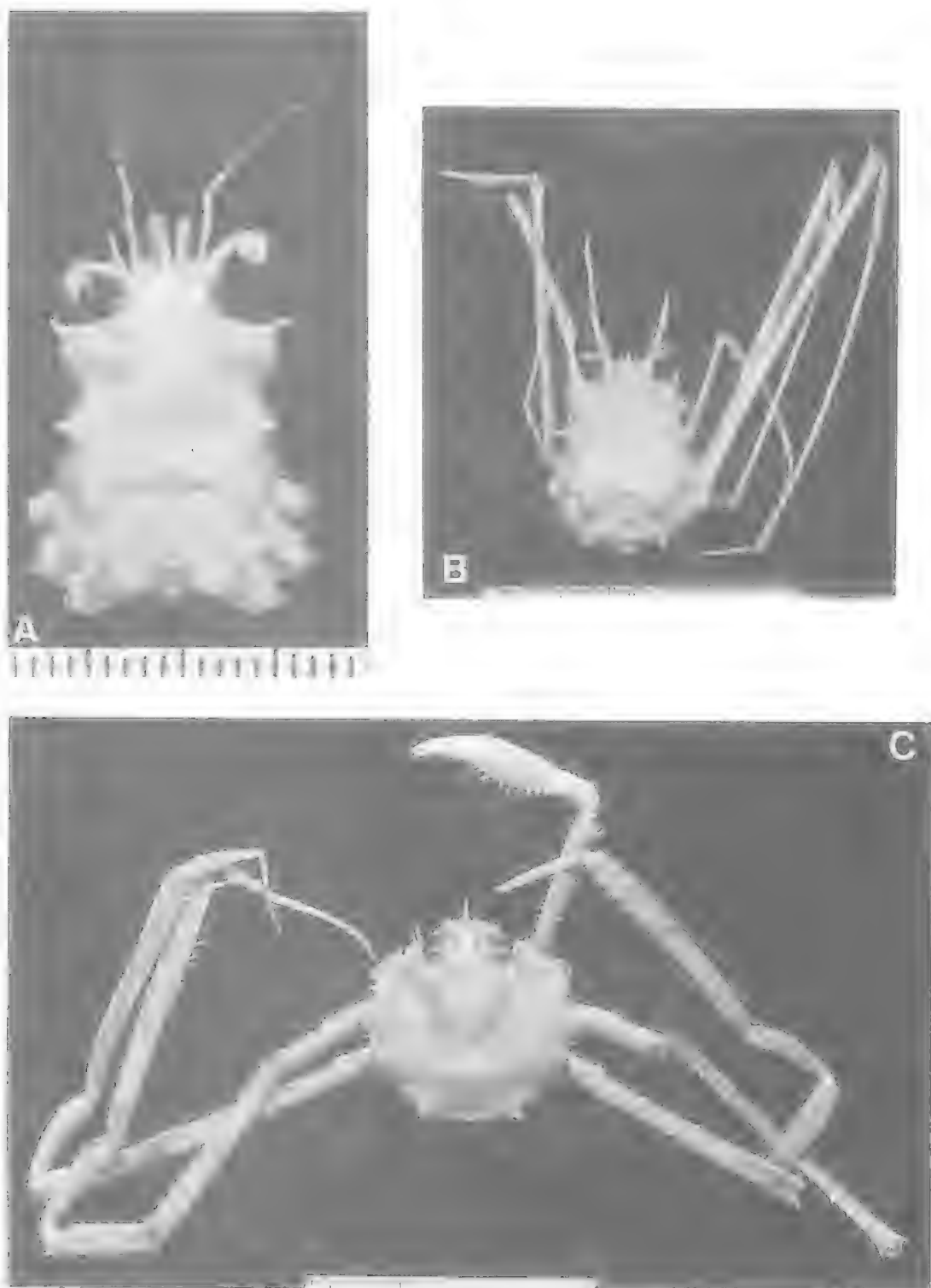


FIG. 3. A, *Latreilopsis hispinosa* Henderson, 1888, ♂, QM W10804; B, *Homolochunia kullar* Griffin and Brown, 1976, ♀ ovig., QM W10595; C, *Platymaia maoria* Dell, 1963, ♂, QM W10664. Scale divisions 1 mm.

is shorter than the supraorbitals but greater than half their length (the ratio described originally by Henderson for *L. bispinosa*). There appears to be variation in the length of the rostrum relative to the supraorbitals, with Barnard (1950) and Serène and Lohavanijaya (1973) figuring the rostrum at greater than half the length of the supraorbitals for *L. bispinosa*. Guinot and Richer de Forges (1981a) describe the length of the rostrum as a character for the separation of *L. gracilipes* from *L. bispinosa*. The rostrum is stated as being relatively longer in *L. gracilipes*. Considering the variation shown by *L. bispinosa* in rostrum length, this does not appear to be a strong character. The rostrum is also said to be orientated differently in *L. gracilipes*, but a comparison between *L. gracilipes* and *L. bispinosa* is difficult from Guinot and Richer de Forges' illustration (pl. VII, figs 1, 1a).

According to Guinot and Richer de Forges the homolian line of *L. gracilipes* differs from that of *L. bispinosa* by being clearly defined posteriorly and forming an angle in the mid-branchial region. The illustration of Barnard (1950, p. 339, fig. 65g) shows these same characters for an *L. bispinosa* specimen from South Africa, and therefore casts some doubt on their usefulness.

Anterior spination of the pterygostome and buccal frame appears to vary somewhat in prominence in *L. bispinosa* according to descriptions of specimens from different localities, and therefore is also of doubtful reliability in separating *L. gracilipes* from *L. bispinosa*.

As *L. gracilipes* was described from only two specimens it would be of interest to re-evaluate the characters which separate it from *L. bispinosa* when more material becomes available.

DISTRIBUTION

Japan, Philippines, Andamans, Kei Islands, east Africa and now Australia (SEQ).

Latreillopsis petterdi Grant, 1905

(Fig. 1B)

Latreillopsis petterdi Grant, 1905, pp.317-9, pl.10, figs 2,2a,2b; Rathbun, 1923, pp.140-3, pl.36; Dell, 1963, pp.224-5; Takeda and Miyake, 1969a, pp. 159-61, fig. 1, pl. 1; Griffin and Brown, 1976, pp.248-9.

Paromola petterdi: Serène and Lohavanijaya, 1973, pp.26-7.

MATERIAL EXAMINED

QM W10586, ♂ (61.2 mm), trawled M.V. 'Iron Summer', 27°35.54'S, 153°56.72'E, 520 m, 31.iii.1983, R. Morton (Q.F.S.); QM W10585, ♀ ovig. (45.1 mm),

trawled M.V. 'Iron Summer', 27°15.33'S, 153°54.01'E, 535 m, 31.iii.1983, R. Morton (Q.F.S.); QM W10587, ♂ (47.4 mm), trawled M.V. 'Iron Summer', 27°54'S, 153°58'E, 490 m, 30.xi.1982, S. Hyland (Q.F.S.); QM W10588, 2 ♀ ovig. (45.6, 43.6 mm), trawled M.V. 'Iron Summer', 27°18'S, 153°54'E, 540 m, 13.viii.1982, G. Smith and J. Burke (Q.F.S.); QM W10581, ♀ ovig. (48.7 mm), ♀ (36.6 mm), trawled M.V. 'Iron Summer', 27°55'S, 154°01'E, 555 m, 30.xi.1982, (Q.F.S.); QM W10584, ♂ (52.8 mm), ♀ (38.6 mm), trawled M.V. 'Iron Summer', 27°35.04'S, 153°57.32'E, 545 m, 31.iii.1983, R. Morton (Q.F.S.); QM W10583, ♂ (56.8 mm), trawled M.V. 'Iron Summer', 27°53.90'S, 154°0.33'E, 560 m, 30.iii.1983, R. Morton (Q.F.S.); QM W10582, ♂ (61.6 mm), trawled M.V. 'Iron Summer', 27°13' to 27°22'S, 153°E, 500-540 m, 2-3.x.1982, M. Holmes (Q.F.S.); QM W10131, ♂ (69.6 mm), trawled 'Craigmin' survey, 26°31'S, 153°48'E, 480 m, 13.ix.1980, (Q.F.S.); QM W10755, ♂ (17.3 mm), trawled M.V. 'Iron Summer', 26.0 nautical miles off Pt Danger, 400 m, 15.xii.1982, G. Smith (Q.F.S.); QM W14912, ♂ (65.8 mm), trawled M.V. 'Iron Summer', 27°13.00'S, 153°52.53'E, 590 m, 9.v.1983, R. Morton (Q.F.S.); QM W14917, ♂ (45.5 mm), trawled M.V. 'Iron Summer', 27°12.83'S, 153°52.87'E, 555 m, 10.v.1983, R. Morton (Q.F.S.).

DISTRIBUTION

From southeast Queensland to South Australia and Tasmania; New Zealand.

Paromola japonica Parisi, 1915

(Figs 2c-e, 4B)

Paromola japonica Parisi, 1915, p.109, pl.3; Balss, 1921, p.111; Sakai, 1935, p.35, pl.2; 1936, p.47, pl.3. *Paromola cuvieri*: Balss, 1921, p.178 (not Risso, 1816). *Homola* (*Parahomola*) *japonica*: Yokoya, 1933, p. 99. *Paromola japonica*: Sakai, 1976, pp.39(key),40, pl.9. ? *Paromola japonica*: Guinot and Richer de Forges, 1981a, pp.538-40, figs 10, 26, pl.111, figs 2,2a,2b.

MATERIAL EXAMINED

QM W10710, ♂ (cl. 37.4 mm [excluding rostrum], cw. 32.8 mm), trawled M.V. 'Iron Summer', 27°45.6'S, 153°58'E, 540 m, 29.vii.1982, P. Dutton (Q.F.S.).

REMARKS

Our specimen agrees in major respects with the description and illustration of the type (Parisi, 1915). Some differences are:

1. The spinulation of the meri of the walking legs is more pronounced (more like that described by Guinot and Richer de Forges, 1981a, pl.3, figs 2, 2a).

2. The meri of the fifth legs are relatively longer in relation to carapace length than in the type.

3. The supraorbital spines and rostrum are relatively longer and appear a little more stout, the

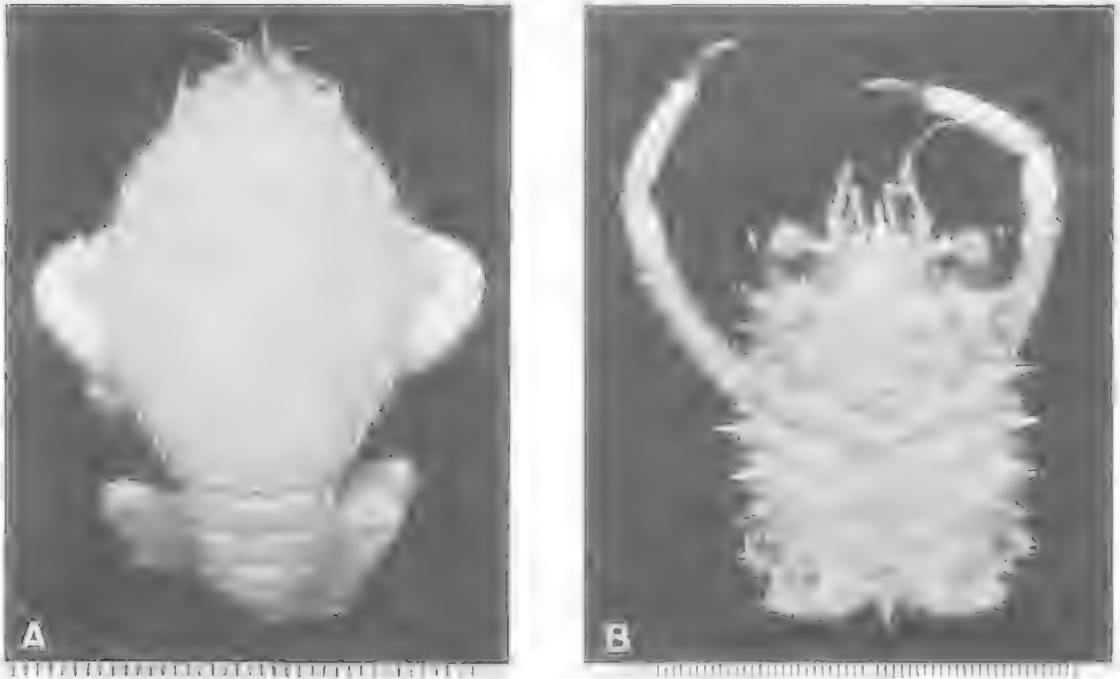


FIG. 4. A, *Notopoides latus* Henderson, 1888, ♂, QM W11501; B, *Paramola japonica* Parisi, 1915, ♂, QM W10710. Scale divisions 1 mm.

branch of the supra-orbitals being slightly more pronounced.

Minor variation in spinulation is also apparent between our specimen and the type photograph by Parisi (1915, pl.3), however similar variation is also evident in other specimens collected from Sagami Bay, and whose identity is therefore fairly certain (cf. Sakai, 1976, pl.9; Guinot and Richer de Forges, 1981a, pl.8, fig. 4).

Our specimen is virtually identical (in carapace appearance) to the specimen from Sagami Bay (♂, 62×50 mm) pictured in Guinot and Richer de Forges, 1981a (pl.8, fig. 4) (determined by Sakai), the only discernible difference being that our specimen has slightly longer supraorbital spines. This could be explained by damage to the Japanese specimen, or variation of this character induced by differing sizes (our specimen can be considered sub-adult as the chelipeds have not taken on the enlarged swollen form of large males). The carapace is also covered in short hairs which extend around the bases of spines but not the tips, as described by Sakai (1976) for Japanese specimens.

Similar or greater variation is also evident if specimens recorded from other localities are considered i.e. specimens from the Loyalty Isles (Guinot and Richer de Forges, 1981a, pl.3, figs. 2

and 3 respectively); and from Hawaii (Edmonson, 1932, pl.1).

Our specimen agrees with that described as ? *Paramola japonica* by Guinot and Richer de Forges (1981a) from the Loyalty Isles in having the merus of p.5 relatively longer than figured and described for large specimens of *P. japonica*. It would seem probable that the lengths of the leg segments relative to carapace length varies with size. The meral segments of the legs also carry spines stronger than described for Japanese or Hawaiian specimens, as in the Loyalty Isles specimens. This character may also vary with size. Our specimen also agrees closely with other comments and description by Guinot and Richer de Forges (1981a) for their specimen from the Loyalty Isles e.g. dactylus and propodus of 5th leg same as Fig. 2G; 1st pleopod agrees well with Fig. 5C; basal antennal segment identical to Fig. 1D except that it is missing the distal outer spine. The 2nd pleopod is a little different from Fig. 5C1 however, which is a Madagascar specimen (see comments below).

The specimen from Madagascar mentioned by Guinot and Richer de Forges (1981a) as questionably belonging to this species could indeed be so, considering the amount of intraspecific variation. They suggest that the Madagascar specimen might

be *P. alcocki* (because of its geography), however this seems unlikely as Sakai (1976) gives the size range of this species as less than 60 mm. Sakai (1976) has figured a *P. alcocki* with enlarged chelae at 40 mm, whereas the Madagascar specimen still had not developed this secondary sex character at 90 mm. However in the light of the points raised, the confusion over the separation of *P. japonica* and *P. alcocki*, and the fact that our pleopod 2 differs a little from that figured by Guinot and Richer de Forges (1981a, fig. 5C1), we are not prepared to make any judgement.

Sakai (1976) considers *P. hawaiiensis* (Edmonson, 1932) to be a synonym of *P. japonica*. Our specimen, although much smaller than the individual described by Edmonson, agrees in general with his description, within the limits of the variation already discussed.

DISTRIBUTION

Japan, Hawaii, the Loyalty Isles and now Queensland, Australia.

Paromolopsis boasi Wood-Mason, 1891 (Fig. 1C)

Paromolopsis boasi Wood-Mason, 1891, p.268, fig. 5; Alcock, 1899a, p.11; 1899b, p.159; 1901, p.65, pl.5, fig. 23; Ihle, 1913, p.60, text-fig. 23B; Gordon, 1950, p.244, text-fig. 16C; Serène and Lohavanijaya, 1973, p. 29, figs 39–42, pl.3; Sakai, 1976, p.43, pl.15, fig. 2; Guinot and Richer de Forges, 1981a, p.540, text-figs 3B, 4L, pl.VI, figs 3, 3a.

MATERIAL EXAMINED

QM W10589, ♀ (39.4 mm), trawled 'Craigmin' survey, 23°15.3'S, 154°21.7'E, 549m, 4.x.1980, (Q.F.S.); QM W10590, 2 ♀ ovig. (37.2, 36.1 mm), trawled M.V. 'Iron Summer', 27°59.37'S, 154°00.12'E, 590m, 31.iii.1983, R. Morton (Q.F.S.); QM W10591, ♂ (36.0 mm), trawled M.V. 'Iron Summer', 27°15.33'S, 153°54.01'E, 535m, 31.iii.1983, R. Morton (Q.F.S.); QM W10592, ♂ (39.3 mm), trawled M.V. 'Iron Summer', 27°35.04'S, 153°57.32'E, 545 m, 31.iii.1983, R. Morton (Q.F.S.); QM W14911, ♂ (34.1 mm), trawled M.V. 'Iron Summer', 27°13.00'S, 153°52.53'E, 590 m, 9.v.1983, R. Morton (Q.F.S.); QM W14918, ♀ ovig. (35.1 mm), 27°12.83'S, 153°52.87'E, 555 m, 10.v.1983, R. Morton (Q.F.S.); QM W11225, ♂ (39.4 mm), trawled M.V. 'Southern Intruder', 23°21'S, 153°23'E, 410 m, 30.xi.1983, P. Davie; QM W11226, ♀ (33.0 mm), trawled M.V. 'Southern Intruder', 23°45'S, 153°07'E, 550m, 29.xi.1983, P. Davie; AM P26553, ♂ (17.2 mm), trawled F.R.V. 'Kapala', 29°52–55'S, 153°43–42'E, 275 fms, 23.viii.1977, N.S.W. State Fisheries; AM P21800, ♂ (34.0 mm), trawled F.R.V. 'Kapala', 29°20–26'S, 153°49–50'E, 250 fms, 12.x.1975, N.S.W. State

Fisheries; AM P21696, ♀ (33.7 mm), trawled F.R.V. 'Kapala', 29°41–32'S, 153°45–47'E, 222–226 fms, 10.x.1975, N.S.W. State Fisheries.

DISTRIBUTION

East India, Andaman Sea, Ceylon, Macassar Sea, Japan, Madagascar, and now within Australia from mid-eastern Queensland to northeast N.S.W.

Family RANINIDAE

Notopoides latus Henderson, 1888 (Fig. 4A)

Notopoides latus Henderson, 1888, pp. 29, 30, pl. 2, fig. 6; Gordon, 1963, pp. 53–4, fig. 13; 1966, p. 345–50, figs 2–4; Bruce and Serène, 1972, pp. 76–81, figs 1–3; Serène and Vadon, 1981, p. 121, pl. 1A; Goeke, 1985, pp. 221, 224, 227 (key), figs 9A–I.

MATERIAL EXAMINED

QM W11501, 1 ♂ (23.8 mm), trawled M.V. 'Southern Intruder', 22°00'S, 153°31'E, 270 m, 1.xi.83, M. Dredge (Q.F.S.).

DISTRIBUTION

Off Kenya and Tanganyika, east Africa; Little Kei Is, Indonesia; the Philippines; and now mid-eastern Queensland, Australia.

Ranilia tenuiocellus sp. nov. (Figs 5a–g, 7B, 8d–f)

MATERIAL EXAMINED

HOLOTYPE: QM W10802, ♂ (19.2 cw., 23.8 cl.), trawled M.V. 'Iron Summer', 400 m, 26.0 n. miles off Pt. Danger, 15.xii.1982, G. Smith (Q.F.S.).

PARATYPES: QM W10803, ♂ (20.0 mm), ♀ (20.0 mm). Location data the same as holotype.

DESCRIPTION

Carapace resembles other species of the genus — strongly convex laterally, evenly convex longitudinally. Dorsal carapace surface anteriorly and antero-laterally finely but obviously granular; punctate and smooth posteriorly. Carapace otherwise with irregular-shaped scars or rugosities placed symmetrically either side of the median line. Carapace length 1.24 × breadth. Antero-lateral tooth strong, sharp, pointed forward and slightly outward.

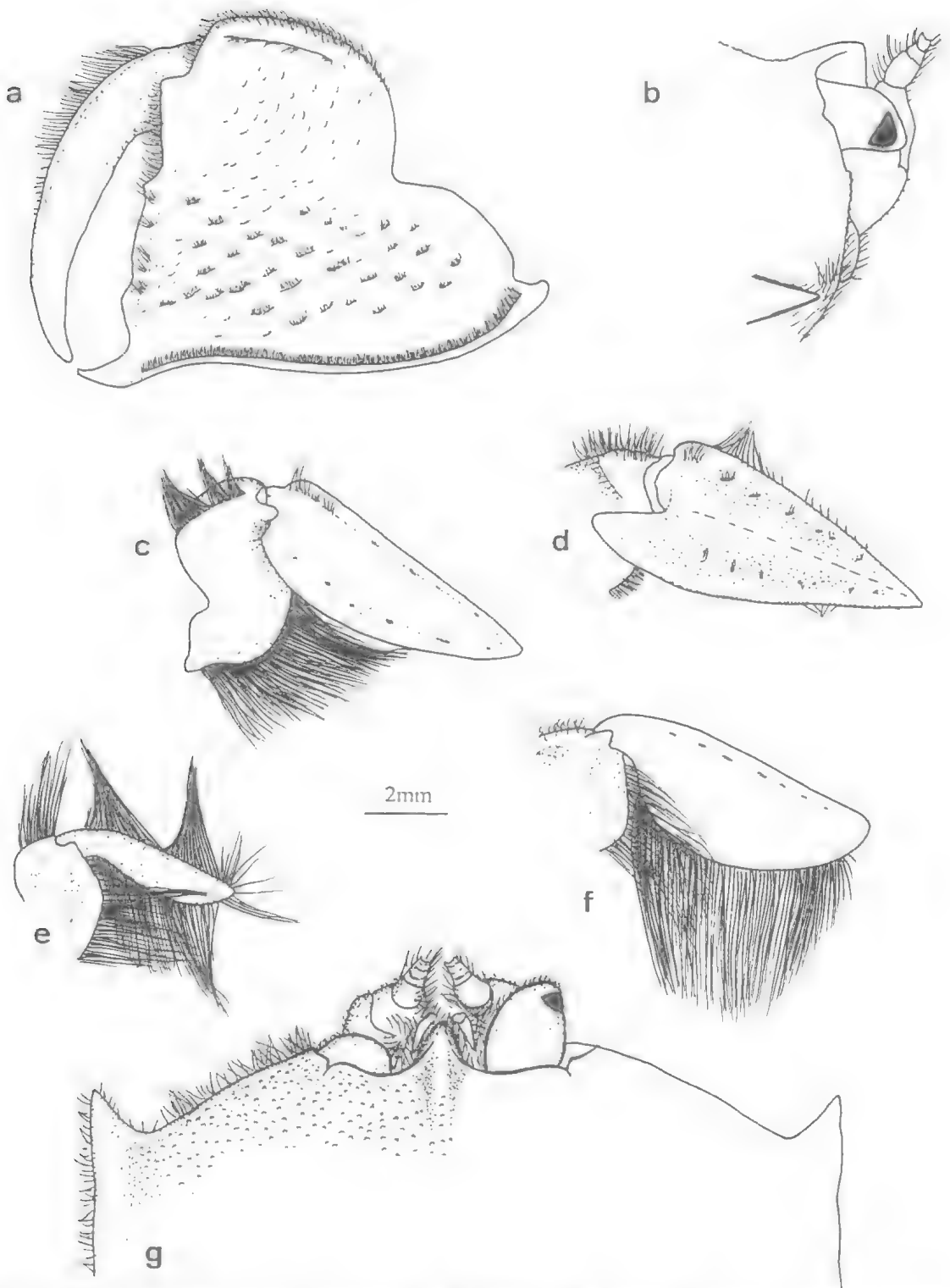


FIG. 5. *Ranilia tenuiocellus* sp. nov., Holotype ♂, QM W10802; a — left chela; b — anterior of carapace, lateral view; c-f — dactyli of first to fourth ambulatory legs; g — anterior of carapace, dorsal view.

Orbit without teeth, v-shaped fissure about level with middle of ocular peduncle, more or less lobed either side of this, raised tubercular ridge starting at level of tip of cornea and running obliquely downward. Rostrum sharply pointed, upturned; rostral carina and sulci project for short distances posteriorly. Rostrum with ventral septum separating ocular peduncles.

Eye peduncle flattened, ovate, folding obliquely downward and backward such that cornea is hidden from view. Cornea reduced, subterminal, triangular in outline. Anterior border of peduncle covered in minute granules and short tomentum. Antennules small, and concealed by the large basal segments of antennae. Third maxilliped slender with ischium smooth and bearing oblique row of longish hairs almost reaching internal edge, and a second row across the proximal internal corner; merus pitted with scattered bristles and short hairs arising from the pits, anterior border of ischium markedly concave.

Chelipeds large, deep, flattened, equal in size; carpus with small distal spine, anterior surface tuberculate, outer surface smooth, upper outer surface striated with short rows of small granules and bearing rows of short hairs; merus outer surface striated and with longish hairs; palm of chela compressed and deep; anterior edge with row of close set hairs, cutting margin sharp, with or without low teeth; fixed finger very short, smooth, and pointed; movable finger with dorsal row of hairs emerging from dorsal groove, curved and without differentiated teeth.

Legs fringed with long hairs; the second pair the longest, first and third subequal, the last the shortest and inserted dorsally. First pair with ischium bearing crest on ventral surface; leading edges of carpus and propodus sharp, and both bearing crests on upper anterior surfaces; dactylus blade-shaped with straight upper margin and convex lower margin. Segments of second pair with sharp leading edges but without additional anterior crests on upper surfaces; dactylus somewhat twisted at insertion and with low, smooth, central ridge on the outer face and strong, posterior distal lobe. Third pair stouter, with carapace and propodus having low anterior crests; merus with posterior border rounded proximally, straight in the distal two-thirds; carpus with strongly projecting distal lobe on posterior border; propodus broad; dactylus blade-shaped but truncated distally. Last pair with carpus deep, flattened, dactylus narrow and elongate.

Male pleopods as figured; first male pleopod

with distinctive calcified plates laterally, reminiscent of lepadid barnacles.

Colour after alcohol preservation pale biscuit.

REMARKS

R. tenuiocellus sp. nov. closely resembles *R. horikoshi* Takeda, and both species differ from all other members of the genus in having degenerated eyes. It is immediately distinguishable from *R. horikoshi* Takeda by the lack of orbital teeth. In this character it is different from all previously described species. *R. tenuiocellus* also differs from *R. horikoshi* Takeda in the following characters:

1. Carapace more finely granular anteriorly and anterolaterally, and posteriorly smooth and punctate rather than 'scaly'.

2. Cornea positioned more or less sub-terminally on ocular peduncle rather than terminally.

3. The shape of the first and second male pleopods differ noticeably from those figured by Takeda (1975, fig. 3a-d). In particular the tip of pleopod two in *R. tenuiocellus* has a more slender 'neck' and a much more pronounced, almost 'beaked' apex.

This species is closely allied to *R. horikoshi* Takeda, however we believe that the strong differences in dentition of the orbit warrants separate species rank.

ETYMOLOGY

The species name refers to the characteristic small corneas, and is derived from the latin *tenuis* meaning weak or feeble and *ocellus* meaning little eyes.

DISTRIBUTION

Off Pt Danger, southeast Queensland.

Ranilla trirufomaculata sp. nov. (Figs 6a-h, 7A, 8a-c)

Notopus ovalis: Tyndale-Biscoe and George, 1962, pp. 90-1 (not *N. ovalis* Henderson, 1888).

MATERIAL EXAMINED

HOLOTYPE: WAM 348-60, ♂ (20.4 mm), 7 miles W. of Cape Contour, Bernier Is., Honolulu dredge, 70 m, sand 16.v.1960, R.W. George on 'Davena'.

PARATYPES: WAM 347-60, ♂, ♀ (18.0, 17.2 mm), 8 miles W. of Wooded Is, Eastern Group, Abrolhos Is., Honolulu dredge, 150 m, coral sand and shell fragments, 12.v.1960, R.W. George on 'Davena': QM W11403, ♀ (24.9 cw.), trawled M.V. 'Southern Intruder', 22°00'S, 153°31'E, 270 m, 1.xi.1983, M. Dredge (Q.F.S.).

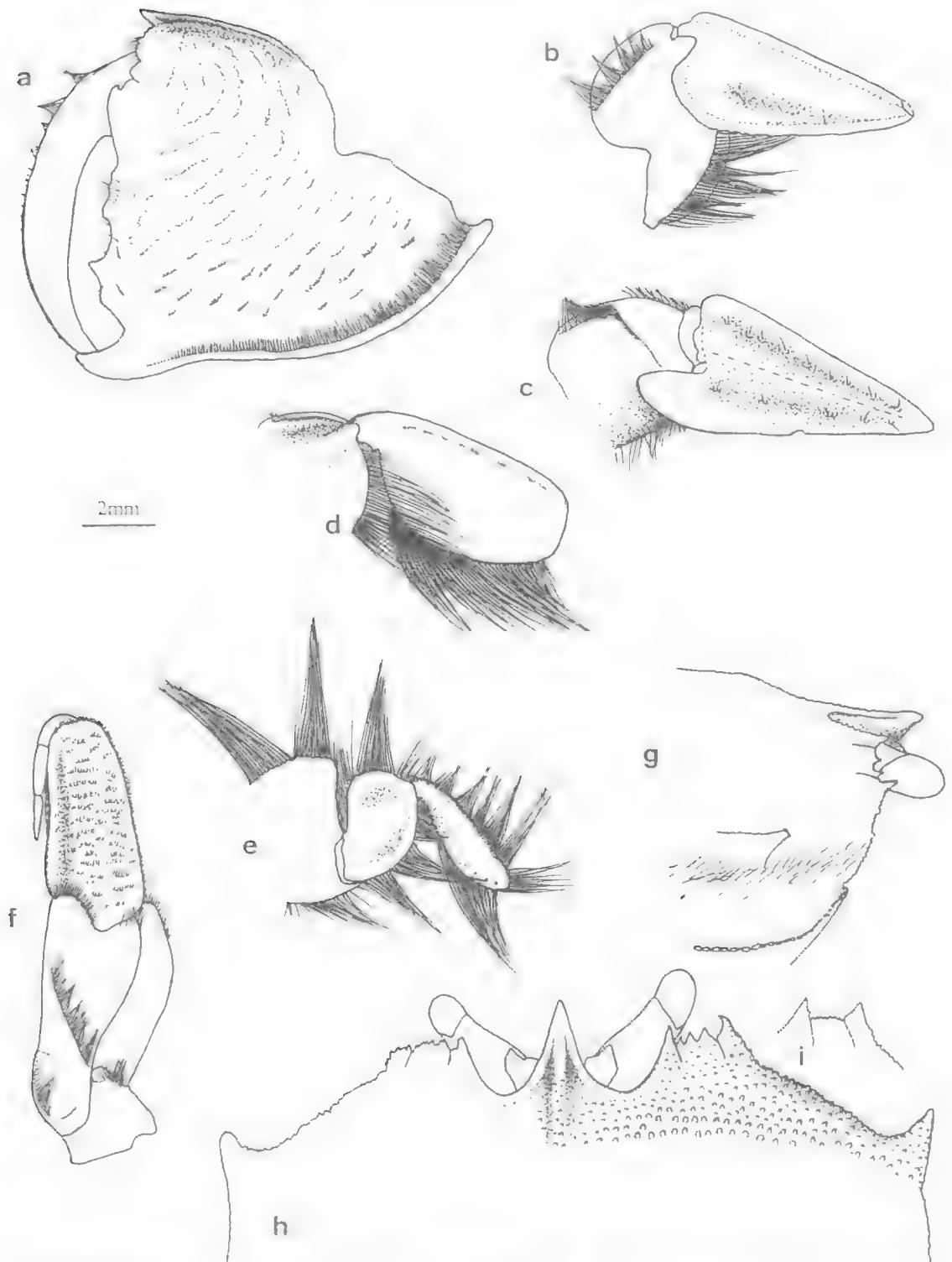


FIG. 6. *Ranilia trirufomaculata* sp. nov., Holotype ♂, WAM 348-60; a — left chela; b-e — dactyli of first to fourth ambulatory legs; f — third maxilliped; g — anterior of carapace, lateral view; h — dorsal view of same; i — more typical spination of supraorbital margin.

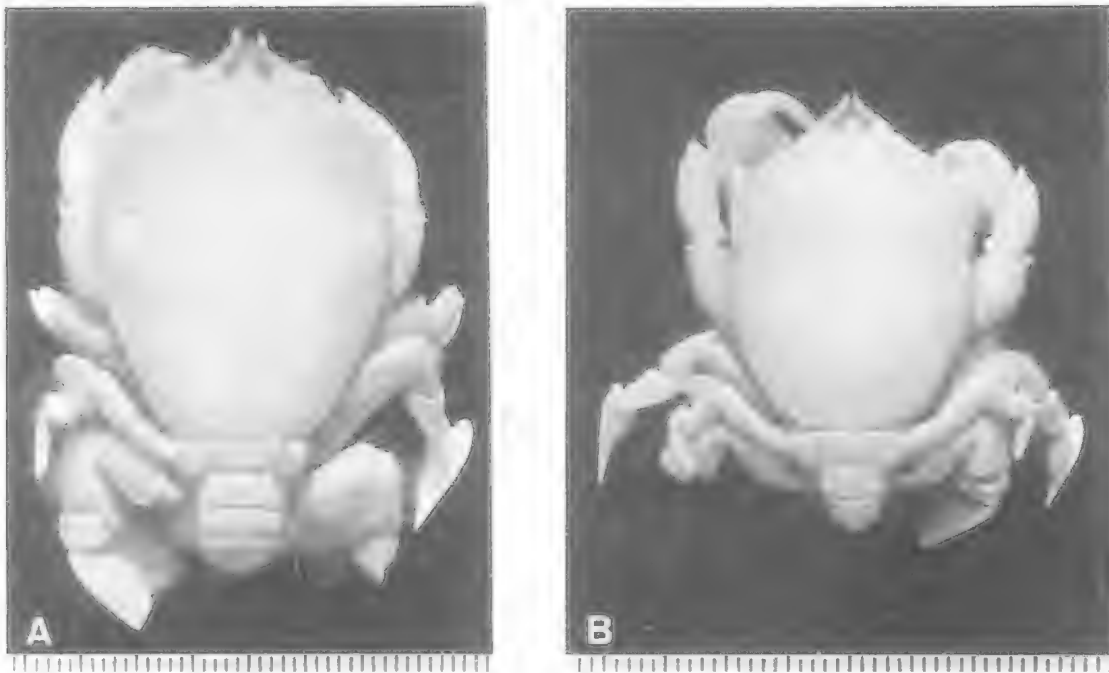


FIG. 7. A, *Ranilia trirufomaculata* sp. nov., Paratype ♀, QM W11403; B, *Ranilia tenuiocellus* sp. nov., Holotype ♂, QM W10802. Scale dimensions 1 mm.

DESCRIPTION

Carapace with dorsal surface finely but obviously tuberculate anteriorly and anterolaterally, becoming smooth and finely punctate posteriorly; irregular-shaped scars or rugosities placed symmetrically either side of the median line. Anterolateral teeth strong, sharp, pointed forward and slightly outward. Carapace length $1.27\text{--}1.29 \times$ carapace breadth.

Orbit with short acute inner and outer teeth connected by a lower granular, sometimes spinous, square cut lobe. Rostrum sharply pointed, slightly upturned. Rostral carina and sulci project a short distance posteriorly. Rostrum with ventral septum separating ocular peduncles. Ratio of distance between external orbital angles and anterolateral teeth within the range $2.06\text{--}2.23$.

Eye peduncle obliquely flattened although almost subparallel in dorsal view; folding obliquely downward and backward such that the cornea is hidden from view. Cornea well developed, terminal, and slightly less than half the length of the eyestalk. Peduncle covered in small granules and a short tomentum anteriorly.

Third maxillipeds of typical form, ischium slightly longer than merus, smooth with oblique row of longish hairs centrally and another short

row across the proximal internal corner. Merus pitted and finely haired, $c. 2.17 \times$ longer than broad.

Chelipeds large, deep, flattened, equal in size; merus with outer surface striated and with longish hairs centrally and down the leading edge bordering a smooth glabrous triangular area; carpus with smooth lower outer surface becoming striated along upper leading edge merging into sharp pointed granules dorsally, a sharp prominent spine present on upper distal margin. Palm of chela compressed and deep; prominent subdistal spine on upper margin; anterior edge with row of close set hairs; outer surface glabrous but indented with striations bearing small hairs; cutting margin sharp with low subacute teeth. Fixed finger very short, smooth and pointed; moveable finger curved with cutting margin sharp and without differentiated teeth, dorsal row of hairs emerging from dorsal groove.

Legs fringed with long hairs; the second pair the longest, first and third subequal, the last the shortest and inserted dorsally. First pair with ischium bearing crest in ventral view; leading edges of carpus and propodus sharp, and both bearing hairy crest on upper anterior surfaces; dactylus blade-shaped with straight upper margin and

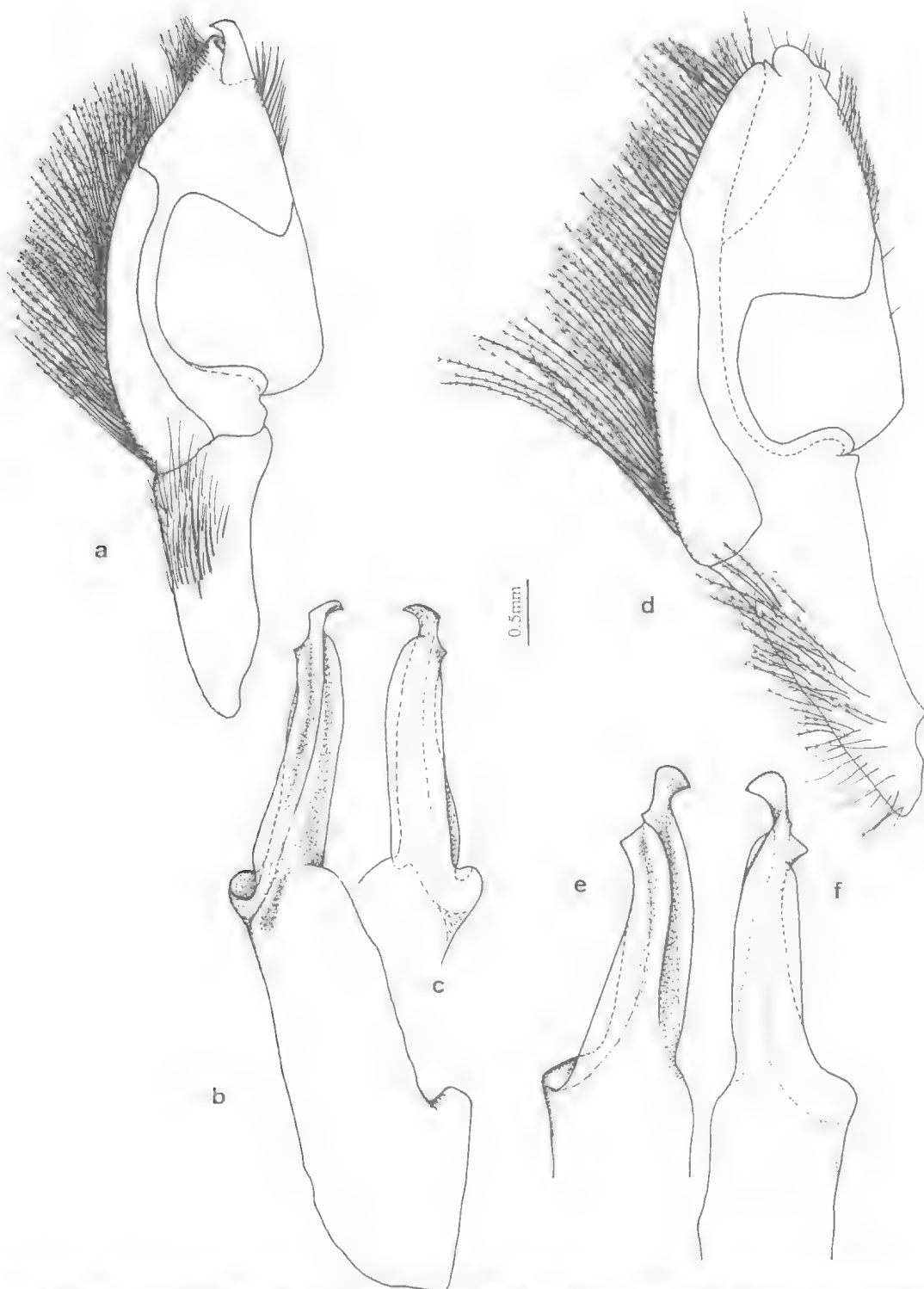


FIG. 8. *Ranilia trirufomaculata* sp. nov., Holotype ♂, WAM 348-60; a — first male pleopod; b — second male pleopod, inner view; c — outer view of same; *Ranilia tenuiocellus* sp. nov., Holotype ♂, QM W10802; d — first male pleopod; e — second male pleopod, outer view; f — inner view of same.

convex lower margin. Segments of second pair with sharp leading edges but without additional anterior crests on upper surfaces; dactylus twisted at insertion and bearing a low smooth central ridge on the outer face and a strong posterior distal lobe. Third pair stouter; merus, carpus and propodus with leading edges sharp; carpus with strongly projecting distal lobe on posterior border; propodus broad; dactylus with anterior border straight, posterior border convex, truncated distally. Last pair with carpus very deep and flattened; dactylus narrow and elongate.

Colour: pale biscuit (in alcohol) with two large rounded orange/red spots laterally and a much smaller spot anterior to these on the mid-line.

REMARKS

R. trirufomaculata is most closely related in form to *R. misakiensis* Sakai from Japan. It differs from that species in the following particulars (based on the type description and figures, and on figures presented by Serène and Umali, 1972):

1. The ratio of distance between the exorbital angles and the anterolateral angles varies from 2.06–2.23 whereas in *R. misakiensis* this is greater, being 2.56 for specimens examined by Serène and Umali (1972) and 2.43 for measurements taken from the figure of the type female.

2. The chelae have a sharp distal spine on the superior border of the palm, this is not described or apparent from available figures, and yet is strongly developed and obvious on our specimens.

3. In *R. misakiensis* the wrist is marked by a raised ridge, which is hairy along the inner upper border, no such ridge is present in any of the present specimens, the inner upper border being evenly rounded and without hairs.

4. The dactylus of the third walking leg seems to project more at the outer distal margin and the truncate terminal edge seems comparatively wider.

5. The ischium and merus of the fourth walking legs are comparatively stouter in *R. misakiensis*.

6. *R. misakiensis* does not have the distinctive red spots dorsally that are obvious on *R. trirufomaculata* even after 28 years in preservative.

7. Although the figures of the pleopod 1 given by Serène and Umali (1972) are very poor it is still apparent that the pleopod 1 of *R. trirufomaculata* is narrower distally, has a different apical configuration and also differs in the size and shape of the lateral calcified plates.

8. The merus of the third maxilliped of *R. misakiensis* appears to narrow distally much more markedly than in the present species (pl. 1, fig. 8 of Serène and Umali, 1972).

The female specimen from Queensland differs slightly from those from Western Australia in that the lateral red spots are situated a little more anteriorly, and the dactyl of the left 3rd walking leg is more sharply and obliquely truncate (that of the right leg is missing). In the absence of more material these differences do not seem enough to erect a separate species or even subspecies.

ETYMOLOGY

The species takes its name from the three large red spots on the dorsal surface of the carapace.

DISTRIBUTION

Only recorded from the vicinity of Abrolhos and Bernier Islands, Western Australia and from off southeastern Queensland. Depths range from 70–270 m.

KEY TO INDO-WEST PACIFIC SPECIES OF *RANILIA* H. MILNE EDWARDS

The genus *Ranilia* now contains twelve species: six from the Atlantic and eastern Pacific — *R. muricata* H. Milne Edwards (type species), *R. constricta* (A. Milne Edwards) and *R. saldanhai* Rodrigues da Costa from the Atlantic Coast of the Americas, *R. angustata* Stimpson and *R. fornicata* (Faxon) from the Pacific coast of the Americas, *R. atlantica* Studer from the Atlantic Coast of Africa; and six from the Indo-west Pacific — *R. orientalis* Sakai, *R. misakiensis* Sakai and *R. ovalis* (Henderson) from Japan, *R. horikoshi* Takeda from the East China Sea, and *R. tenuicellus* sp. nov. and *R. trirufomaculata* sp. nov. from Australia. The following key should serve to separate the Indo-west Pacific species.

1. Cornea of eye markedly reduced, and not visible when peduncle is retracted 2
Cornea of eye of normal form 3
2. Supraorbital border with three conical teeth *R. horikoshi*
Supraorbital border without teeth developed *R. tenuicellus*
3. All four pairs of ambulatory legs hatchet-shaped *R. ovalis*
Only first two pairs of ambulatory legs hatchet-shaped, third pair elongate, quadrangular in shape 4
4. Carapace broader, the breadth being more than 3/4 the total length, Fronto-orbital distance less than one half the breadth of carapace 5
Carapace narrower, the breadth being less

- than $3/4$ the total length. Fronto-orbital distance more than one half the breadth of carapace *R. orientalis*
5. Distance between antero-lateral angles 2.0–2.25 times the fronto-orbital distance; chelae with sharp distal spine on superior border of palm, and carpus without raised ridge on inner upper border; three red spots dorsally *R. trirufomaculata*
- Distance between anterolateral angles 2.4–2.6 times the fronto-orbital distance; chelae without spine on superior border of palm, and with raised ridge on inner upper border of carpus; carapace reddish-brown and without dorsal spots *R. misakiensis*

***Mursia microspina* sp. nov.**
(Figs 9a–g, 10)

MATERIAL EXAMINED

HOLOTYPE: QM W11437, 1 ♂ (cw. 27.9 mm, cb. excluding spines 26.7 mm, cl. 23.1 mm), trawled M.V. 'Iron Summer' 27°35'S, 153°50'E, 210 m, G. Smith (Q.F.S.), 15.xii.1982.

DESCRIPTION

Carapace broader than long (carapace width excluding spines $1.16 \times$ carapace length); coarsely granulate over entire surface although more finely granulate on frontal and orbital regions; seven more or less distinct rows of tubercles radiating backwards from behind fronto-orbital region; front narrow (5.4 times in cl., 2.7 times in fronto-orbital width), three lobed, middle lobe projecting well beyond lateral lobes; anterolateral margins evenly convex, beaded with granules, and with 9–10 small lobes which are most prominent anteriorly becoming indistinct towards the lateral spine; lateral spine very short (c. 11 times in cl.), slender, curved upwards to horizontal in posterior view; posterolateral border noticeably shorter than anterolateral (0.84 times); posterior margin short (4.2 times in cl.), three lobed with laterals being pronounced while median is low and broad.

Inner suborbital lobe triangular with outer border much longer than inner border; separated from outer-orbital cup by a V-shaped sinus.

Merus of cheliped with three spines near distal outer margin, innermost low and rounded, outermost largest, prominent and sharply pointed (subequal or a little larger than lateral carapace spine). Outer face of wrist coarsely granulate, a row of three larger granular tubercles behind carpal/propodal joint, inner distal border pointed

triangular. Outer face of palm also coarsely granular, four or five slightly larger granules along lower border just prior to fixed finger, eleven low granular tubercles and one spine arranged in uneven oblique rows running from serrate crest backwards towards joint, the spine is situated towards proximal end of lower border and is much smaller than the adjacent meral spine. Upper border with high crest and cut into nine teeth, largest distally. Fixed finger deflexed. Inner face of palm smooth. Dactyl with row of 27 stridulatory tubercles.

Ambulatory legs and abdomen are missing.

First male pleopod stout, evenly tapering to a blunt tip; fine spinules distally. Second male pleopod long and slender, constricted from near the middle and markedly recurved distally.

No indication of live colouring or patterning persists on the alcohol preserved specimens.

REMARKS

M. microspina resembles *M. aspera* Alcock and *M. hawaiiensis* Rathbun and differs from all other species by having short lateral spines, and small inconspicuous teeth on the outer inferior border of the palm. It differs from *M. aspera* by: 1. having a broader front (c. 5 times in cl. compared with c. 8 times in cl.); 2. median lobe of front protruding markedly beyond laterals; 3. granules on carapace and chelae much finer; 4. the teeth on the inferior border are not subequal small and acuminate, the proximal one being spinous; 5. *M. aspera* is a large species being nearly three times larger than the present adult specimen.

It differs from *M. hawaiiensis* by:

1. The posterolateral border is more markedly shorter than the anterolateral border ($0.84 \times$ compared with $0.95 \times$).

2. The length to breadth (excluding lateral spines) ratio differs, being 1.16 in *M. microspina* and c. 1.25 in *M. hawaiiensis* (measurements given by Rathbun (1893) and Sakai (1976) and derived from pl. 18, fig. 3 in Rathbun (1906)).

3. The tubercles of our new species are arranged in seven longitudinal rows as opposed to five and are not as distinctly separated from the surrounding granules (compared with the figure of Rathbun (1906) and her description of 1893).

4. The lateral frontal lobes are less protruberant.

5. The tubercles on the lower inferior border of the chela are small and well separated from each other with no indication of being 'elongated and crested, each rather continuous' as described by Sakai (1965a, p. 55), and appears to be the case from Rathbun's figure (1906, pl. 18, fig. 4).

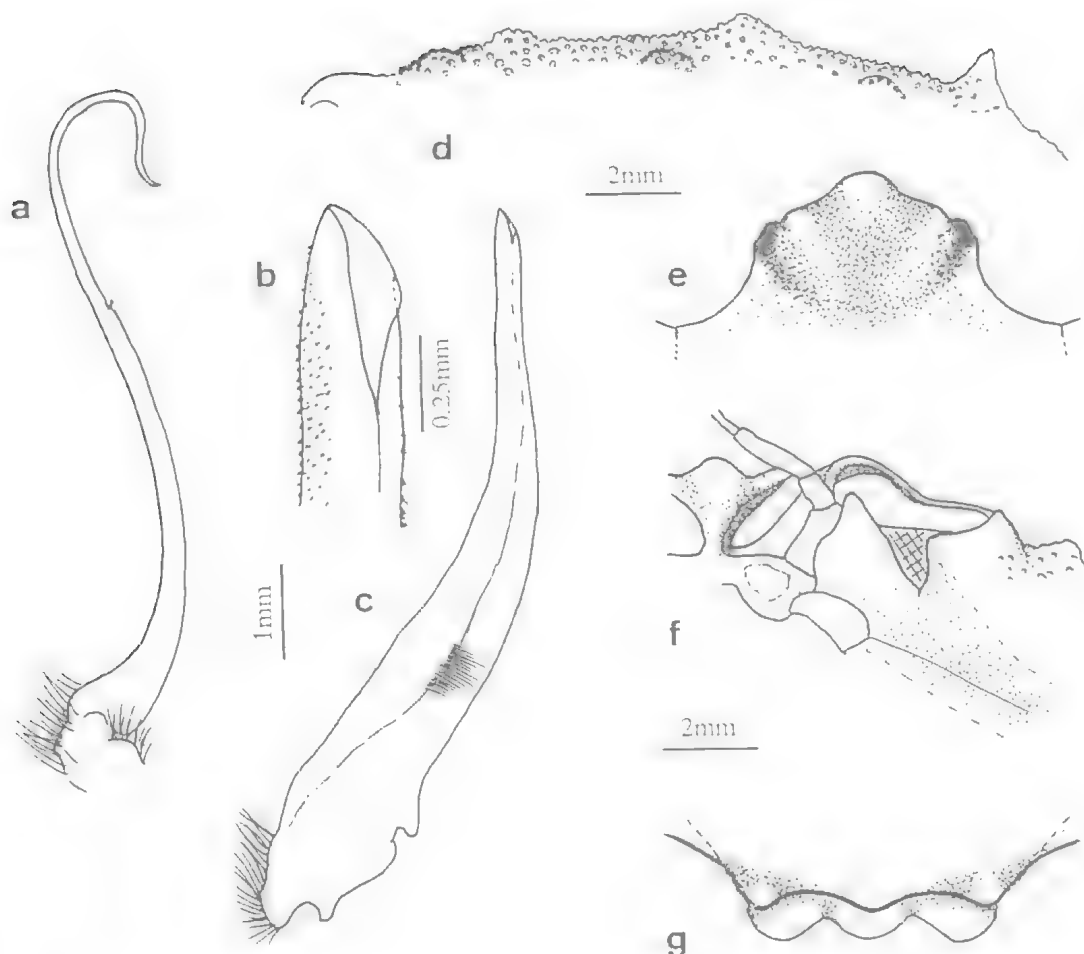


FIG. 9. *Mursia microspina* sp. nov., Holotype ♂, QM W11437; a — second male pleopod; b — view of the tip of first male pleopod; c — full view of same; d — outer-inferior portion of propodus of right cheliped; e — frontal view; f — ventral orbit; g — posterior carapace margin and first abdominal segment.

6. The tip of the second male pleopod is much less out-curved.

This species is very closely related to *M. hawaiiensis* but as only minor variation has been described within that species the divergences shown by the present specimen can be considered significant and justify its description as new.

ETYMOLOGY

The species derives its name from the relatively small lateral spines on the carapace.

DISTRIBUTION

Known only from the type locality, southeast Queensland, Australia.

Family LEUCOSIIDAE

Arcania undecimspinos de Haan, 1841

Arcania undecimspinos de Haan, 1841, p.135, pl.33, fig. 8; Alcock, 1896, p.266 (earlier literature); Sakai, 1937, p.124, figs 15b,16, pl.10, fig. 1; 1976, pp.90-1, pl.28, fig. 1; Holthuis and Sakai, 1970, p.119 (English), p.311 (Japanese), pl.11, fig. 2; Campbell, 1971, p.41.

Arcania granulosa Miers, 1877, p.240, pl.38, fig. 29.

MATERIAL EXAMINED

QM W10132, ♀ (23.0 mm), trawled 'Craigmin' survey, 22°56.1'S, 152°43.2'E, 360 m, 3.x.1980, Q.F.S.



FIG. 10. *Mursia microspina* sp. nov., Holotype ♀, QM W11437. Scale divisions 1 mm.

DISTRIBUTION

India to Japan and Queensland, Australia. Previously recorded from southeast Queensland by Miers (1877) and Campbell (1971). Bathymetric range 30 to 360 m.

Family MAJIDAE

Cyrtomaia horrida Rathbun, 1916 (Fig. 1D)

Cyrtomaia horrida Rathbun, 1916, pp.532-3; Yokoya, 1933, p.145; Sakai, 1938, p.242; 1976, pp.180-1, pl.60; Griffin, 1976, pl.88, fig. 3; Guinot and Richer de Forges, 1982b, pp.36-40, figs 19A-E, 20A,B, 23C,C1,E; 1986, pp. 119-20, pl. 6A-C; Griffin and Tranter, 1986a, pp.24(key), 25-26.

Cyrtomaia Smithii tenuipedunculata Ihle and Ihle-Landenberg, 1931, pp.152-4 (in part, 1 ♂ spec. only), *fide* Griffin and Tranter, 1986a, pp.25, 26.

MATERIAL EXAMINED

QM W10141, ♀ ovig. (45.2 mm), trawled 'Craigmin' survey, 23°15.3'S, 154°21.7'E, 549 m, 4.x.1980, Q.F.S.; QM W10142, ♂ (31.8 mm), trawled 'Craigmin' survey, 23°15.3'S, 154°21.7'E, 549 m, 4.x.1980, Q.F.S.; QM W10140, ♀ (46.6 mm), trawled 'Craigmin' survey, 22°36.7'S, 154°14.0'E, 522 m, 4.x.1980, Q.F.S.; QM W11227, ♀ (30.4 mm), trawled M.V. 'Southern Intruder', 23°22'S, 152°45'E, 310-350 m, 30.xi.1983, P. Davie; QM W11228, ♂ (35.9 mm), trawled M.V. 'Southern Intruder', 23°54'S, 153°01'E, 465 m, 29.xi.1983, P. Davie; QM W11229, ♀ (44.1 mm), ♂ (44.9 mm), trawled M.V. 'Southern Intruder', 23°21'S, 153°23'E, 410 m, 30.xi.1983, P. Davie; QM W11230, 2 ♂ (49.8, 49.0 mm), trawled M.V. 'Southern Intruder', 23°07'S, 153°24'E, 400 m, 6.ix.1983, Q.F.S.; QM W11231, ♀ ovig. (43.5 mm), trawled M.V. 'Southern Intruder', 23°15'S, 153°18'E, 425 m, 6.ix.1983, Q.F.S.; QM W14922, ♂ (55.1 mm), trawled M.V. 'Southern Intruder', 23°28'S, 153°00'E, 110 m, 3.viii.1984, Q.F.S.; AM P34553, ♀, trawled off Java, Mortensen Java — South Africa Expedition, 7°42'S, 114°0'E, 450 m,

4.iv.1929, mud with corals, Sigsbee Trawl; AM P20207, ♂ ovig., ♂, trawled South China Sea, Ganton Trawl, 16°09.4'N, 114°31.6'E to 16°11'N, 114°29.7'E, 266–295 m, white muddy sand, 12.vi.1964, Fisheries Research Sin, Hong Kong.

REMARKS

Our specimens agree very well with the description of the holotype provided by Guinot and Richer de Forges (1982b). Some points however should be discussed. Our large male did not have a clearly defined intestinal spine, although younger males (QM W10142) and all females did have this spine. Also, the largest male, although slightly smaller than the holotype, appears more swollen in the cardiac region (extremely swollen when compared with younger males and females). The large ♀ (AM P34553) from Java, was suitably pilose although in general our specimens had a sparse tomentum. All had some longer hooked hairs on the mesogastric as has been described (Guinot and Richer de Forges, 1982b).

The protogastric spines are described by Guinot and Richer de Forges (1982b) as being practically rectilinear and inclined towards the front. Although the spines on our specimens are inclined towards the front, they are varying divergent. The large ♀ (AM P34533) from Java is the least divergent, being almost parallel, however the largest males are quite divergent (there is some indication of damage near the bases and this may have resulted in unnatural development).

DISTRIBUTION

Philippines, Japan, and now Australia (off mid-eastern Queensland).

Cyrtomaia suhmii Miers, 1886

Cyrtomaia suhmii Miers, 1886, pp.16–7, pl.3, figs. 2.

Cyrtomaia suhmi: Griffin, 1974, pp.9–10; 1976, pp.252–3, fig.6; Griffin and Brown, 1976, pp.252–3, fig. 6; Guinot and Richer de Forges, 1982b, pp. 16, 21, figs 10, 11A–B, 23B; 1986, pp. 116–9, figs 11B, 12A–B, 14A–C, pl. 5A–D, F–I; Griffin and Tranter, 1986a, pp. 24(key), 30–1, fig. 9c–g; 1986b, pp. 352–3, figs 1, 2.

MATERIAL EXAMINED

QM W10608, ♀ (72.3 mm), trawled M.V. 'Iron Summer', 27°14–19'S, 153°52–59'E, 530–540 m, 24.ix.1982, G. Smith (Q.F.S.); QM W10611, ♂ ovig. (74.1 mm), trawled M.V. 'Iron Summer', 27°13–22'S, 153°E, 500–540 m, 2–3.x.1982, M. Holmes (Q.F.S.); QM W10609, ♂ (74.7 mm), trawled M.V. 'Iron Summer', 27°18'S, 153°54'E, 540 m, 13.viii.1982, G.

Smith and J. Burke (Q.F.S.); QM W10612, ♂ (65.7 mm), trawled M.V. 'Iron Summer', 27°13'S, 153°22'E, 520 m, 25.iii.1983, R. Morton (Q.F.S.); QM W10610, ♀ (76.8 mm), ♂ (67.6 mm), trawled M.V. 'Iron Summer', 27°34'S, 153°56'E, 540 m, 24.iii.1983, R. Morton (Q.F.S.); QM W14908, 2 ♂ (61.6, 63.4 mm), trawled M.V. 'Iron Summer', 27°19.91'S, 153°53.47'E, 600 m, 10.v.83, Q.F.S.; QM W14909, ♂ (66.8 mm), trawled M.V. 'Iron Summer', 27°13.00'S, 153°52.53'E, 590 m, R. Morton (Q.F.S.); QM W14916, ♀ ovig. (73.7 mm), trawled M.V. 'Iron Summer', 27°12.83'S, 153°52.87'E, 555 m, 10.v.83, R. Morton (Q.F.S.); QM W11232, ♂ (66.8 mm), trawled M.V. 'Southern Intruder', 23°45'S, 153°07'E, 550 m, 29.xi.1983, P. Davie; QM W11233, ♂ (69.5 mm), trawled M.V. 'Southern Intruder', 23°17'S, 153°56'E, 460 m, 30.xi.1983, P. Davie.

REMARKS

According to Griffin and Tranter (1986a) 'Most of the specimens previously described have no spine in the orbit between the eye and the postorbital spine, but there is a granule in this position in the holotype (Guinot and Richer de Forges, 1982b: fig.11) and a small spine in the juvenile specimen from Java (Ihle and Ihle-Landenberg, 1931). In the specimens from off the eastern Australian coast there is a small spine about a third the length of the postorbital spine'. Our specimens resemble the specimens from off New South Wales examined by Griffin and Tranter (1986a) and all have the small spine in the orbit although the prominence of this spine varies somewhat.

In his original description Miers uses the spelling *suhmii* although on the accompanying figure caption the spelling *suhmi* is also used. Subsequently the latter spelling has been always used without explanation. As the former spelling was used by Miers throughout the description this was clearly the intended form and should be used for the species.

DISTRIBUTION

Southern India, Bay of Bengal, Philippines, Indonesia, Japan, northwestern and eastern Australia.

Leptomithrax waitei (Whitelegge, 1900)

Chlorinoides waitei Whitelegge, 1900, pp.143–6, pl.33.

Leptomithrax waitei: Rathbun, 1918, p.23; Griffin, 1966, p.285 (key); Griffin and Brown, 1976, p.253; Griffin and Tranter, 1986a, p. 208 (key).

MATERIAL EXAMINED

QM W10146, 2 ♀ (65.6, 65.6 mm), trawled 'Craigmin' survey, 26°20'S, 153°53'E, 300 m, 13.ix.1980, Q.F.S.;

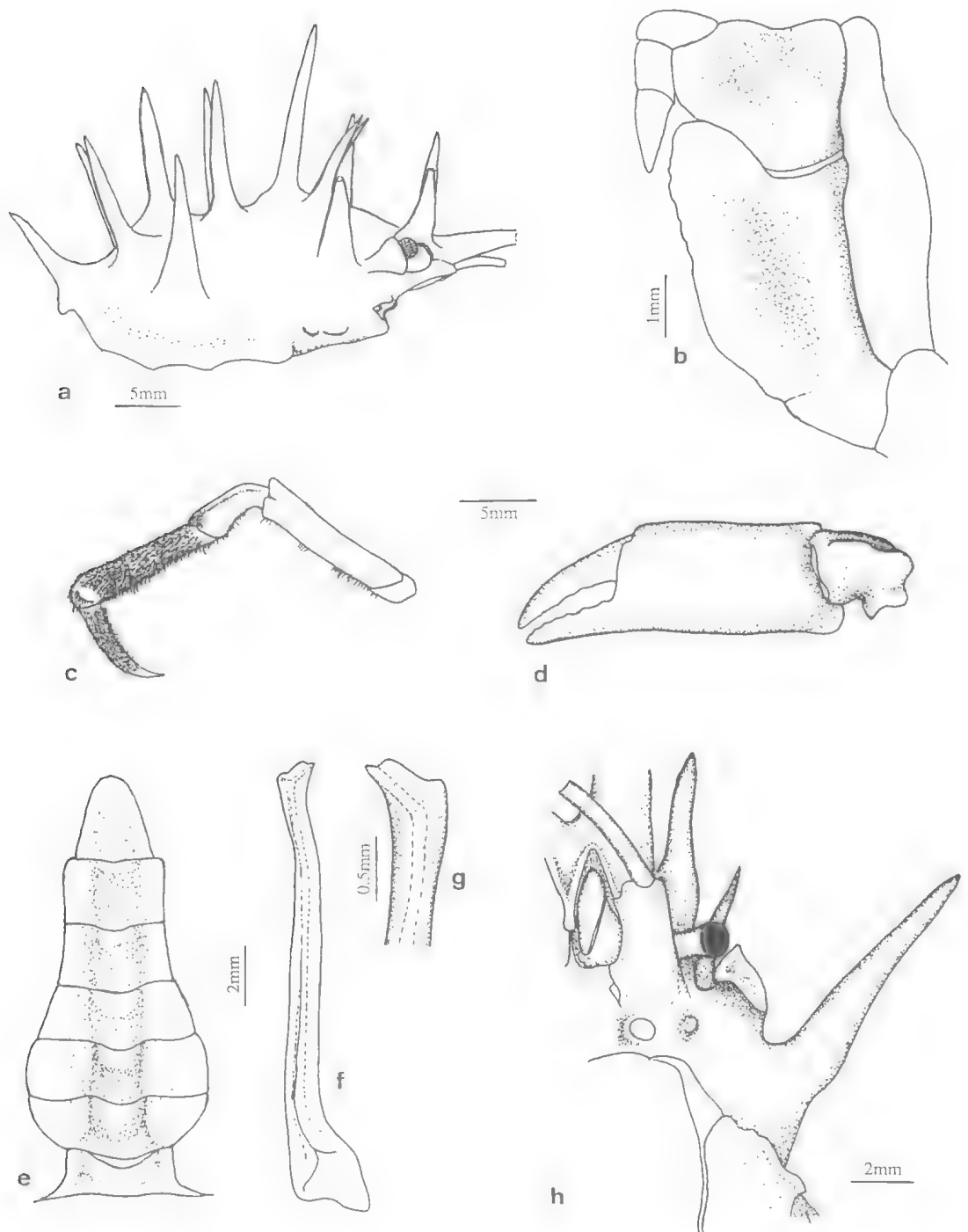


FIG. 11. *Rochinia griffini* sp. nov., Holotype ♂, QM W11245; a — lateral view of carapace; b — third maxilliped denuded; c — fourth ambulatory leg (Paratype ♀, QM W11246); d — left cheliped; e — abdomen; f — first male pleopod, abdominal view; g — sternal tip of same; h — ventral orbit.

QM W10143, ♂ (118.2 mm), ♀ (102.5 mm), trawled 'Craigmin' survey, 23°30'S, 153°04'E, 540 m, 29.ix.1980, Q.F.S.; QM W10144, ♂ (116.8 mm), 3 ♀ ovig. (101.9, 95.0, 95.6 mm), trawled 'Craigmin' survey, 7.x.1980, Q.F.S.; QM W10145, 2 ♀ ovig. (98.8 mm), trawled 'Craigmin' survey, 23°30'S, 153°04'E, 540 m, 29.ix.1980, Q.F.S.; QM W10562, 2 ♀ (35.2, 37.1 mm), trawled M.V. 'Iron Summer', 27°13'S, 153°45'E, 200 m, 24.iii.1983, R. Morton (Q.F.S.); QM W10561, ♂ (23.6 mm), ♀ (43.0 mm), trawled M.V. 'Iron Summer', 27°35'S, 153°50'E, 210 m, 15.xii.1982, G. Smith (Q.F.S.); QM W10560, ♀ (61.7 mm), ♂ (79.6 mm), trawled M.V. 'Iron Summer', 27°41.7'S, no longitude, 260 m, 10.vi.1983, P. Dutton (Q.F.S.).

DISTRIBUTION

Eastern Australia, from mid-eastern Queensland to southern New South Wales.

Platymaia fimbriata Rathbun, 1916 (Fig. 13A-C)

Platymaia fimbriata Rathbun, 1916, pp.531-2; Ihle and Ihle-Landenberg, 1931, pp.149-52; Takeda and Miyake, 1969b, pp.497-8; Sakai, 1976, pp.176-8, pl.58; Griffin, 1976, p.206, fig. 9; Guinot and Richer de Forges, 1986, pp. 88 (key), 106-9, figs 7A-D, 8A-B, pl. 1F,G; Griffin and Tranter, 1986a, pp.44 (key), 46, fig. 10 i,j; 1986b, p. 354.

MATERIAL EXAMINED

QM W10620, ♂ (36.9 mm), ♀ ovig. (41.2 mm), ♀ (38.0 mm), trawled M.V. 'Iron Summer', 26°31'S, 153°48'E, 570 m, 13.xii.1982, G. Smith (Q.F.S.); QM W10625, ♀ (39.5 mm), trawled M.V. 'Iron Summer', 27°13'-22'S, 153°E, 500-540 m, 2-3.x.1982, M. Holmes (Q.F.S.); QM W10624, ♀ juv. (30.2 mm), trawled M.V. 'Iron Summer', 27°13.52'S, 153°53.46'E, 620 m, 31.iii.1983, R. Morton (Q.F.S.); QM W10621, ♂ (39.2 mm), trawled M.V. 'Iron Summer', 27°18'S, 153°54'E, 540 m, 13.viii.1982, G. Smith and J. Burke (Q.F.S.); QM W10622, ♂ (39.6 mm) trawled M.V. 'Iron Summer', 27°53.90'S, 154°00.33'E, 560 m, 30.iii.1983, R. Morton (Q.F.S.); QM W10623, ♀ ovig. (44.3 mm), trawled M.V. 'Iron Summer', 27°59.37'S, 154°00.12'E, 590 m, 31.iii.1983, R. Morton (Q.F.S.); QM W10626, ♀ juv. (30.6 mm), trawled M.V. 'Iron Summer', 27°13.69'S, 153°54.93'E, 600 m, 31.iii.1983, R. Morton (Q.F.S.); QM W14907, ♀ juv. (30.3 mm), trawled M.V. 'Iron Summer', 27°19.91'S, 153°53.47'E, 600 m, 10.v.1983, Q.F.S.; QM W14910, ♂ (29.6 mm), ♀ juv. (30.7 mm), trawled M.V. 'Iron Summer', 27°13.00'S, 153°52.53'E, 590 m, R. Morton (Q.F.S.); QM W14915, ♀ juv. (29.8 mm), trawled M.V. 'Iron Summer', 27°12.83'S, 153°52.87'E, 555 m, 10.v.1983, R. Morton (Q.F.S.); QM W10137, ♂ (39.4 mm), trawled 'Craigmin' survey, 22°36.7'S, 154°14.0'E, 522 m, 4.x.1980, Q.F.S.; QM W10138, 2 ♀ ovig. (49.8, 39.3 mm), 3 ♂ (37.2, 38.0, 40.9 mm), trawled 'Craigmin' survey, 23°15.3'S, 154°21.7'E, 549 m, 4.x.1980, Q.F.S.;

QM W11237, ♀ ovig. (37.8 mm), trawled M.V. 'Southern Intruder', 23°21'S, 153°23'E, 410 m, 30.xi.1983, P. Davie; QM W11238, ♀ ovig. (45.2 mm), trawled M.V. 'Southern Intruder', 23°45'S, 153°02'E, 550 m, 29.xi.1983, P. Davie; QM W14920, ♂ (37.7 mm), trawled M.V. 'Southern Intruder', 23°37'S, 153°16'E, 590 m, 9.viii.1983, Q.F.S.

REMARKS

As noted by Griffin and Tranter (1986b) spinulation of the carapace and dorsal surface of the last two pairs of ambulatory legs is highly variable. We were able to distinguish three groups: those that were as spinulose as the type series; those with a marked reduction in carapace spines and with only granules or very small spinules on the last two pairs of ambulatory legs; and an intermediate group. These three groups were easily sorted and variation was not obviously continuous. The spiny specimens were very common, the smooth and the intermediates much rarer. The tip of the first male pleopod also showed variation between the groups.

As the forms sometimes occurred sympatrically, and differences were of degree only we cannot consider them separate species.

DISTRIBUTION

Northwestern and eastern Australia, Indonesia, Philippines and Japan.

Platymaia maoria Dell, 1963 (Fig. 3C)

Platymaia maoria Dell, 1963, pp.247-51; Guinot and Richer de Forges, 1986, pp. 88(key), 109-12, figs 9A-D, 10E,F, pl. 4A, B; Griffin and Tranter, 1986a, pp.44(key), 46-7, fig. 10g, h, pl.59.

MATERIAL EXAMINED

QM W10664, ♀ (44.9 mm), trawled M.V. 'Iron Summer', 27°14-19'S, 153°52-54'E, 530-540 m, 24.ix.1982, G. Smith (Q.F.S.); QM W14921, ♀ (49.0 mm), trawled M.V. 'Southern Intruder', 23°46'S, 153°11'E, 600 m, 26.iv.1984, Q.F.S.

DISTRIBUTION

New Zealand, eastern Australia.

Platymaia remifera Rathbun, 1916 (Fig. 14C)

Platymaia remifera Rathbun, 1916, pp.530-1; Serène and Lohavanijaya, 1973, pp.48-9, figs 79-92, pl.VIII, figs A-C; Guinot and Richer de Forges, 1986, pp. 102-5, figs 6A-D, 10L-M, pl. 2A-C.



12. *Rochinia griffini* sp. nov., Paratype ♂, QM W11246. Scale divisions 1 mm.

Platymaia wyvillethomsoni: Serène and Vadon, 1981: 123, 128; Griffin and Tranter, 1986a, pp. 44 (key), 47–8, fig. 10g, h, pl. 5, fig. a.

not *Platymaia wyville-thomsoni* Miers, 1886, pp. 13–14, pl. 2, fig. 1.

MATERIAL EXAMINED

QM W10133, 2 ♀ (37.7, 34.7 mm), trawled 'Craigmin' survey, 22°36.7'S, 154°14.0'E, 522 m, 4.x.1980, Q.F.S.; QM W10134, ♀ (38.3 mm), trawled 'Craigmin' survey, 23°30'S, 153°04'E, 540 m, 20.ix.1980, Q.F.S.; QM W10136, 2 ♂ (38.0, 34.0 mm), ♀ (35.3 mm), trawled 'Craigmin' survey, 23°15.3'S, 154°21.7'E, 549 m, 4.x.1980, Q.F.S.; QM W10135, ♂ (37.8 mm), trawled 'Craigmin' survey, 23°30'S, 153°04'E, 540 m, 20.ix.1980, Q.F.S.; QM W11239, 5 ♀ (35.9, 36.4, 37.1, 39.1, 39.5 mm), 2 ♀ juv. (29.3, 29.4 mm), 7 ♂ (28.0, 31.7, 37.2, 39.1, 39.6, 40.6, 43.8 mm), trawled M.V. 'Southern Intruder', 23°21'S, 153°23'E, 410 m, 30.xi.1983, P. Davie; QM W11240, ♂ (30.3 mm), ♀ (39.2 mm), trawled M.V. 'Southern Intruder', 23°22'S,

152°45'E, 310–350 m, 30.xi.1983, P. Davie; QM W11243, ♂ (39.7 mm), ♀ (40.9 mm), trawled M.V. 'Southern Intruder', 23°54'S, 153°01'E, 465 m, 29.xi.1983, P. Davie; QM W11244, 6 ♀ (34.4, 37.3, 37.6, 39.5, 39.9, 40.6 mm), 2 ♀ juv. (29.9, 34.9 mm), 10 ♂ (31.9, 32.3, 35.5, 35.7, 36.5, 36.5, 36.9, 36.9, 37.2, 38.2 mm), trawled M.V. 'Southern Intruder', 23°21'S, 153°23'E, 410 m, 30.xi.1983, P. Davie; QM W11241, ♂ (36.5 mm), trawled M.V. 'Southern Intruder', 23°45'S, 153°07'E, 550 m, 29.xi.1983, P. Davie; QM W11242, 2 ♂ (37.7, 39.5 mm), trawled M.V. 'Southern Intruder', 23°52'S, 153°02'E, 650 m, 29.xi.1983, P. Davie.

REMARKS

There is still uncertainty concerning the identities of *P. remifera* and *P. wyvillethomsoni*. Griffin (1976, p. 208) states, 'it is clear that there is considerable variation in the tuberculation and spination of the carapace in this species [*P. wyvillethomsoni*]. Most particularly this concerns

the orbit and the posterior and posterolateral portions of the carapace'. Guinot and Richer de Forges (1986) however still use the absence of a spine on the supraorbital margin as a way of defining *P. remifera*. Further their illustration of the tip of the first male pleopods of what they consider as *P. remifera* differs to a certain degree from Griffin and Tranter's (1986a) illustration of a *P. wyvillethomsoni* from eastern Australia.

Our specimens are certainly conspecific with those examined by Griffin and Tranter (1986a) from eastern Australia and the first male pleopods are identical. The illustration of the first male pleopod of one of Rathbun's (1918) specimens (of *P. wyvillethomsoni*) from the Great Australian Bight given by Guinot and Richer de Forges (1986) (as *P. aff. wyvillethomsoni*) also appears to indicate a departure in form from a typical eastern Australian specimen and to what extent such variation can be considered inter- or intraspecific needs to be decided. Unfortunately *P. wyvillethomsoni* was described from a single female and therefore it is difficult to assess if the size of the supraorbital spine on that specimen is aberrant. Guinot and Richer de Forges (1986) feel that the holotype is the only specimen of *P. wyvillethomsoni* so far reported on. Richer de Forges (pers. comm.) after examining a part of our material, considers it to be identical with that reported on by Guinot and Richer de Forges (1986) from the Philippines, and as none of our specimens show significant spine development on the supra-orbital margin we follow Guinot and Richer de Forges, as the last revisers, and refer to our specimens as *Platymaia remifera*.

DISTRIBUTION

Philippine Islands, South China Sea, eastern Australia.

Pleistacantha oryx Ortmann, 1893 (Fig. 14A)

Pleistacantha oryx Ortmann, 1893, p. 39; Sakai, 1965a, pp. 69–70, text-figs 10b,d, pl. 30, fig. 2; 1976, pp. 172–4, text-fig. 93, pl. 55; Griffin, 1974, p. 28; 1976, p. 209; Guinot and Richer de Forges, 1986, pp. 126–9, figs 15A–C, 16A,C,Ea, 18A–D, pl. 7A–D; Griffin and Tranter, 1986a, pp. 49 (key), 51–2.

Pleistacantha oryx (sic): Takeda and Miyake, 1969b, pp. 492–3.

Pleistacantha moseleyi: Sakai, 1938, pp. 234–6, fig. 20, pl. 34, figs 2,3 (non *Pleistacantha moseleyi* Miers, 1886).

MATERIAL EXAMINED

QM W10596, ♂ (35.3 mm), trawled M.V. 'Iron Summer', 28°04'S, 153°57'E, 400 m, 28.vi.82, P. Dutton (Q.F.S.).

Mortensen Pacific Expedition: East China Sea, 32°17'N, 128°11'E, 198 m, trawl No. 6, 14.v.1914, ♀ (38.7 mm); Japan, Nagasaki, ♂ (54.5 mm); Japan, Sagami Sea, Okinose, 540 m, 28.vi.1914, 2 ♂ (17.5, 19.5 mm), ♀ juv. (10.2 mm), 3 ♀ ovig. (18.4, 16.5, 19.5 mm).

Mortensen Java — S. Africa Exped. Stn 15, Bali Sea, 7°29'S, 114°49'E, ca. 240 m, Sigsbee trawl, sand and mud with concretions, 10.iv.1929, ♂ (20.8 mm).

REMARKS

Our specimen was separated from *P. moseleyi* by the characters listed by Griffin (1974, 1976) and Griffin and Tranter (1986a). It does however appear that there may be another species being confused with *P. oryx* which matures at a much larger size. Our specimen is extremely close in appearance to the figure of Sakai (fig. 93, 1976) in having very widely divergent pseudorostral spines and marked carapace spination. Sakai's specimen was an unusually large ♀.

Two other specimens collected by Th. Mortensen (Mortensen Pacific Expedition) one from Nagasaki and one from the East China Sea were examined at the Australian Museum (where they were on loan from the Zoological Museum, University of Copenhagen). These were also large specimens and the latter had the widely divergent pseudorostral spines of Sakai's specimen (unfortunately broken off on the former). Takeda and Miyake (1969b) reported on another unusually large, immature specimen from the East China Sea, although apparently their specimen was not as spiny as those we have examined.

True *P. oryx* appear to mature at between 15 and 20 mm carapace breadth (in both sexes) and seem to be consistent in form, especially in the shape of the rostrum and dorsal spination. It is possible that *P. rubida* may also be confused with *P. oryx* although the rostral spines are supposed to be very short on that species.

We feel we are not in a position to pursue this matter and therefore include our specimen within *P. oryx*. They are obviously closely allied and it seems likely that if two species are involved the small specimens of the larger species would be difficult to separate.

DISTRIBUTION

Japan, East China Sea, Philippine Islands, Java, Andaman Sea, west Arabian Sea and now Australia (SEQ).

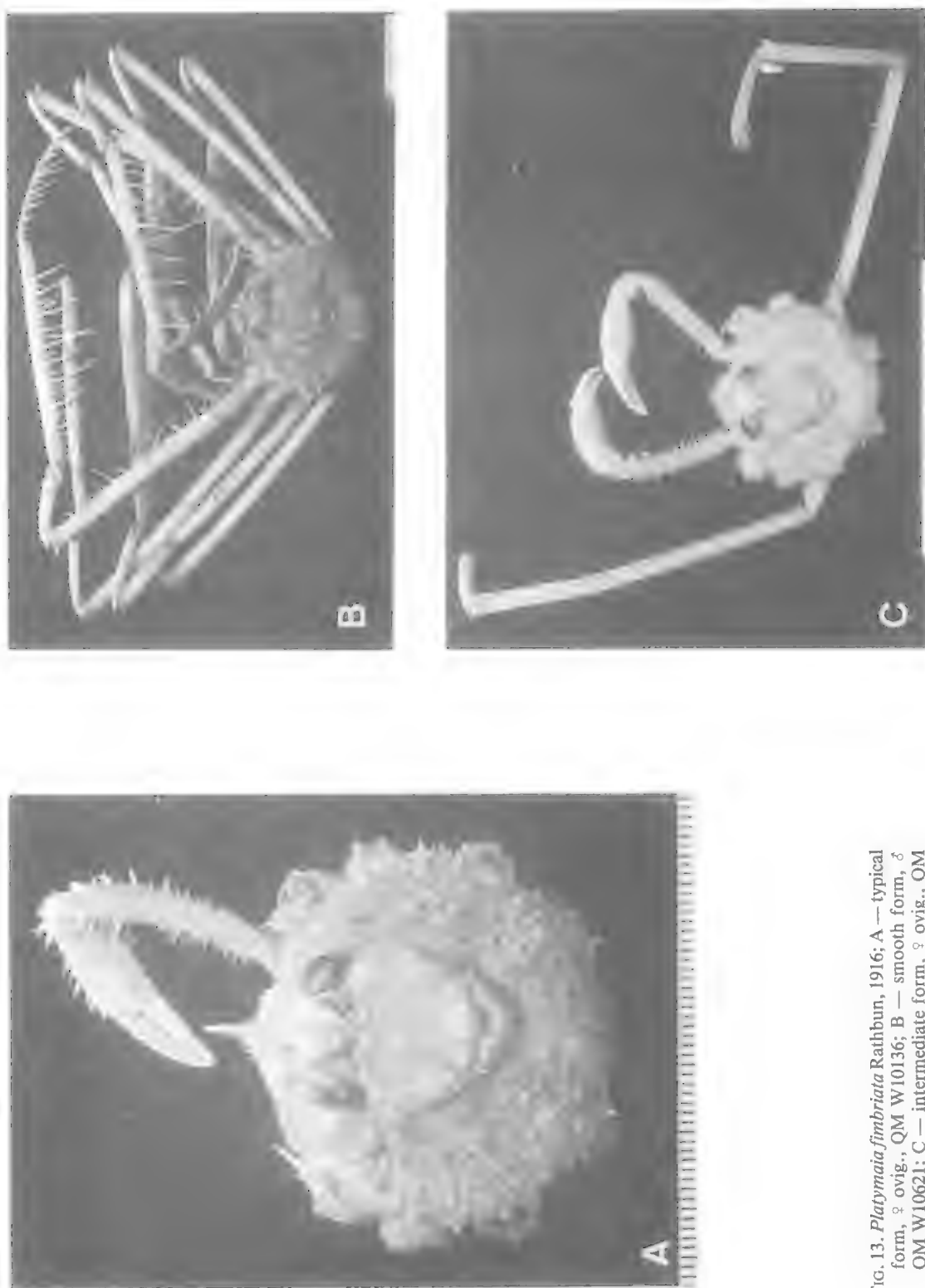


FIG. 13. *Platymaia fimbriata* Rathbun, 1916; A — typical form, ♀ ovig., QM W10136; B — smooth form, ♂ QM W10621; C — intermediate form, ♀ ovig., QM W11238. Scale divisions 1 mm.

***Rochinia griffini* sp. nov.**
(Figs 11a–h, 12)

MATERIAL EXAMINED

HOLOTYPE: QM W11243, ♂ (18.5 mm), trawled M.V. 'Iron Summer', 27°59.37'S, 154°00'E, 590 m, 31.iii.1983, R. Morton (Q.F.S.).

PARATYPES: QM W11247, ♀ (11.9 mm), trawled M.V. 'Iron Summer', 27°44'S, 153°52'E, 220 m (Est.), 30.vii.1982, P. Dutton (Q.F.S.); QM W11246, ♀ (17.5 mm), trawled M.V. 'Iron Summer', 27°35.45'S, 153°56.72'E, 520 m, 31.iii.1983, R. Morton (Q.F.S.); AMP32090, ♀ juv. (cl. 42 mm), trawled F.R.V. 'Kapala' off Point Danger, northern N.S.W., 540 m.

DESCRIPTION

Carapace pyriform and with a thick tomentum of closely-set tangled hairs and a few longer finer hairs. Dorsal surface with fifteen long acute spines — a cardiac, mesogastric and intestinal, along the medial line; and laterally, three branchials, one hepatic, one protogastric and one supra-orbital. Orbit with a cupped post-orbital process. The pseudorostral spines are broken in the male holotype, but in the juvenile female specimen, are greater than three quarters of the carapace length; they are divergent from the base in all specimens.

Eyes are small with darkly pigmented cornea, freely moveable and retract into a cupped post-orbital process. Basal antennal joint narrow, widest at base of antennules, truncated; moveable segments clearly visible below rostrum, second segment shorter than first, flagellum longest, one or two stout bristles at internal distal ends of first and second moveable segments.

Male chelipeds much stouter than legs and much longer than length of carapace (including rostrum); ischium triangular in cross-section, with spine on upper distal angle; carpus with sharp carinae on upper outer edge and inner ventral edge; palm of cheliped rectangular, c. 1.8 times as long as broad, smooth and glabrous; moveable finger c. 0.75 times length of palm; fingers with a series of low rounded teeth along cutting edge and with a slight gap when closed. Female chelipeds only slightly stouter than legs and shorter than the length of the carapace (including rostrum), carinae on carpus less pronounced, fingers with cutting edges touching throughout length when closed. Cheliped of juvenile female covered with a short tomentum, unlike adults.

First ambulatory leg considerably longer than others; merus about equal to length of carpus and propodus, c. 1.4 times length of carapace (including rostrum). Length of legs decreasing posteriorly, Dactyli strong and recurved in distal half.

Male abdomen of 7 free segments, smooth; third segment about 1.8 times wider than sixth segment, sixth segment 1.5 times as wide as long; seventh segment slightly longer than wide, broadly convex apically. Male sternum smooth.

First pleopod of male straight, relatively broad and only slightly tapering; tip with shoulder on outer edge, and inner edge inclined and produced obliquely, ending in an acute tip at aperture.

Colour: After preservation — pale biscuit; adult female with pink on distal ends of fingers of chelae, juvenile female with dark brown tips to the fingers.

The holotype male bore an areolone almost totally covering its back.

REMARKS

Griffin and Tranter (1986a) recorded, with reserve, one specimen of this species as *Rochinia pulchra*, but indicated it was probably new. This species is like *R. pulchra* in having many long carapace spines, and as in *R. pulchra* the supra-orbital spine, hepatic spine and protogastric spine are all long, slender and upright. It does however differ from *R. pulchra*, as Griffin and Tranter (1986a) indicated, by having fewer carapace spines — only one protogastric on each side, not two; only one mesogastric spine; and one spine on the branchial margin posterolaterally.

It appears to us that *R. griffini* is more closely allied to those species with strong preorbital spines and prominent epibranchial spines. Griffin and Tranter (1986b) list seven such species or probable species: *R. riversandersoni* (Alcock 1895); three species previously confused with *R. riversandersoni* but as yet undescribed (a Jolo Sea species, see Griffin, 1976; a South China Sea species, see Serène and Lohavanijaya, 1973; and a Kermadec species, see Yaldwyn and Dawson 1976); *R. sibogae* Griffin and Tranter, 1986; *R. galathea* Griffin and Tranter, 1986; and *R. soela* Griffin and Tranter, 1986.

R. griffini differs from *R. soela* and the South China Sea species in having a spine rather than a tubercle on the cardiac region. It differs from *R. sibogae* (and *R. soela*) because those two species have a large hepatic plate fused to the postorbital lobe. *R. galathea* differs by its very broad petaloid hepatic spine. The Jolo Sea species and *R. riversandersoni* differ in having sharply conical tubercles on the dorsal branchial region rather than the long spines of *R. griffini*. The Kermadec species described by Yaldwyn and Dawson (1976) is very similar to *R. griffini* but differs in having relatively short, broad, supraorbital spines, and only small gastric spines which appear from the

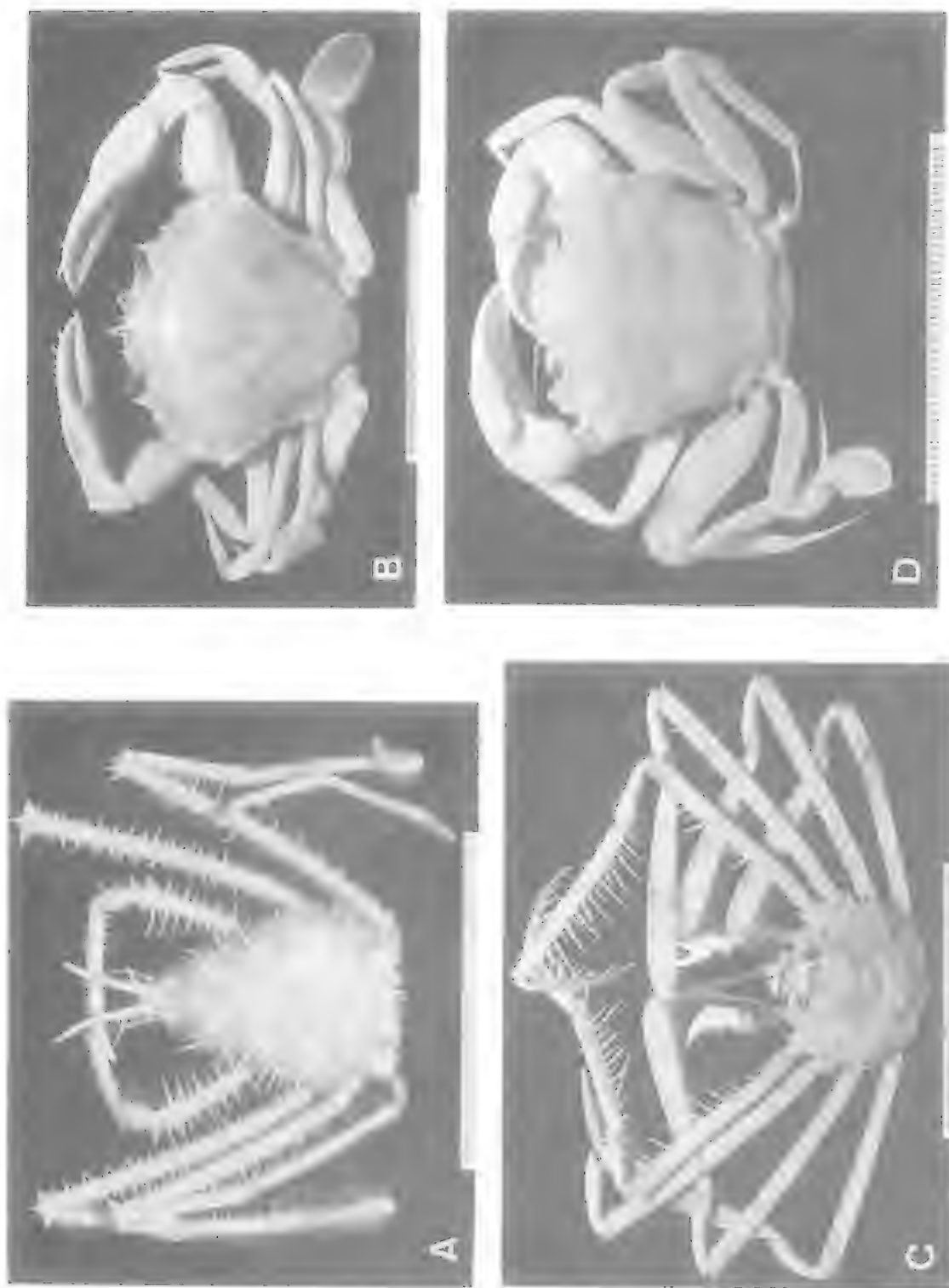


FIG. 14. A, *Pleistacanthia oryx* Ortmann, 1893, ♀, QM W10596; B, *Ovalipes mollieri* (Ward, 1933), ♀, QM W10564; C, *Platyndia remifera* Rathbun, 1916, ♀, QM W11240; D, *Benthochascon hemingi* Alcock and Anderson, 1899, ♂, QM W11236. Scale divisions 1 mm.

illustrations to be no more than sharp tubercles and which 'may be reduced to a low tubercle in small specimens'.

ETYMOLOGY

The species is named to honour Dr Des Griffin for his contribution to majid taxonomy.

DISTRIBUTION

Australia, from SEQ to northern N.S.W.

Benthochascon hemingi Alcock and Anderson, 1899 (Fig. 14D)

Benthochascon hemingi Alcock and Anderson, 1899, p.10; Alcock, 1899a, p.69, pl.3, fig. 2; 1899b, p.15; Alcock and MacGilchrist, 1905, pl.76, figs 4,4a; Doflein, 1904, p.90, pl.29, figs 1, 2, pl. 41, figs 1, 2; Sakai, 1965a, pp.39, 44, pl.6, figs 2; 1976, pp.333-4, pl.114.

Carcinonectes pacificus Stephenson, 1972a, pp.129-30, fig. 3; 1972b, p.3(key).

MATERIAL EXAMINED

QM W10575, ♂ (43.8 mm), trawled M.V. 'Iron Summer', 27°35.04'S, 153°57.32'E, 545 m, 31.iii.1983, R. Morton (Q.F.S.); QM W10576, ♂ (49.1 mm), trawled M.V. 'Iron Summer', 27°35.54'S, 153°56.72'E, 520 m, 31.iii.1983, R. Morton (Q.F.S.); QM W10577, ♂ (48.8 mm), trawled M.V. 'Iron Summer', 27°15.33'S, 153°54.01'E, 31.iii.1983, R. Morton (Q.F.S.); QM W10578, ♂ (49.7 mm), trawled M.V. 'Iron Summer', 27°35.54'S, 153°56.72'E, 520 m, 31.iii.1983, R. Morton (Q.F.S.); QM W10579, ♂ (51.6 mm), trawled M.V. 'Iron Summer', 27°53.90'S, 154°00.33'E, 560 m, 30.iii.1983, R. Morton (Q.F.S.); QM W10580, ♂ (46.6 mm), trawled M.V. 'Iron Summer', 27°13'S, 153°22'E, 520 m, 25.iii.1983, R. Morton (Q.F.S.); QM W10152, ♂ (61.9 mm), trawled 'Craigmin' survey, 23°28'S, 153°19'E, 562 m, 20.ix.1980, Q.F.S.; QM W10154, ♂ (47.1 mm), trawled 'Craigmin' survey, 23°15.3'S, 154°21.7'E, 549 m, 4.x.1980, Q.F.S.; QM W10153, 2 ♂ (49.1, 50.7 mm), trawled 'Craigmin' survey, 22°36.7'S, 154°14.0'E, 522 m, 4.x.1980, (Q.F.S.); QM W11235, ♂ (52.4 mm), trawled M.V. 'Southern Intruder', 23°21'S, 153°23'E, 410 m, 30.xi.1983, P. Davie; QM W11236, ♂ (64.0 mm), 2 ♀ (46.0, 48.8 mm), trawled M.V. 'Southern Intruder', 23°22'S, 152°45'E, 310-350 m, 30.x.1983, P. Davie.

REMARKS

Carcinonectes Stephenson, 1972, and its sole species *C. pacificus* Stephenson, 1972, must become junior subjective synonyms of *Benthochascon* Alcock and Anderson, 1899, and *B. hemingi* Alcock and Anderson, 1899, respectively. Stephenson's erection of *Carcinonectes* appears to

have been based on the presumption that the specimen he examined belonged to the subfamily Carcininae, and this presumption apparently caused him to look no further in his search for its identity. *Benthochascon* may well be more appropriately placed in the Carcininae where Stephenson felt his specimen should be.

DISTRIBUTION

Japan, Andaman Sea, New Caledonia and now eastern Australia (mid-eastern and southeast Qld).

Charybdis (Gonioneptunus) bimaculata (Miers, 1886)

Goniosoma variegatum, var. *bimaculatum* Miers, 1886, p.191, pl.15, figs 3, 3a-c.

Charybdis (Gonioneptunus) bimaculata: Leene, 1938, pp.126-9, figs 70, 71; Stephenson, Hudson and Campbell, 1957, pp.504-5, figs 2J, 3K, pl.3, fig. 4, pl.4H, pl.5A; Sakai, 1976, p.364, pl.128, fig. 1.

Charybdis (Goniohellenus) bimaculata: Moosa, 1981, pp. 145-6.

MATERIAL EXAMINED

QM W10151, ♂ (37.9 mm), trawled 'Craigmin' survey, 22°51.7'S, 152°45.7'E, 261 m, 3.x.1980, Q.F.S.; QM W10150, 4 ♂ (37.3, 38.1, 39.8, 42.7 mm), trawled 'Craigmin' survey, 21°30'S, 152°56'E, 240m, 22.ix.1980, Q.F.S.

DISTRIBUTION

India and Maldives to Japan, the Philippines and eastern Australia (from mid-eastern Queensland to Botany Bay, New South Wales).

Charybdis (Charybdis) miles (de Haan, 1835)

Portunus (Charybdis) miles de Haan, 1835, p.41, pl.11, fig. 1.

Charybdis (Goniosoma) miles: Alcock, 1899a, p.62; Chopra, 1935, p.486, text-fig. 13; Shen, 1937, p.123, text-fig. 13.

Charybdis (Charybdis) miles: Leene, 1938, p.38, figs 10-13, pl.4F; Stephenson, 1961, p.116; Sakai, 1976, pp.358-9, pl.124; Moosa, 1981, p. 145.

MATERIAL EXAMINED

QM W10149, ♂ (80.9 mm), trawled 'Craigmin' survey, 23°10.6'S, 152°12.3'E, 135 m, 2.x.1980, Q.F.S.; QM W11397, ♂ (97.4 mm), trawled M.V. 'Southern Intruder', 23°06'S, 153°02'E, 150 m, 28.viii.1983, M. Dredge (Q.F.S.).

DISTRIBUTION

India, Gulf of Oman, Singapore, Japan, Phil-

ippines, and Australia. Known to occur in depths from 20 to over 200 m (Stephenson 1972b).

***Ovalipes molleri* (Ward, 1933)
(Fig. 14B)**

Aeneacancer molleri Ward, 1933, pp.381-3, pl.23, fig. 11.

Ovalipes molleri: Stephenson and Rees, 1968, pp.237-9, figs 1H, 2G, 3G, 4G, pls 37A, 40B, 41B, 42H; Dawson and Yaldwyn, 1974, pp.46-47; Griffin and Brown, 1976, p.254.

MATERIAL EXAMINED

QM W10571, 4 ♀ (28.8, 29.9, 46.0, 61.5 mm), trawled M.V. 'Iron Summer', 27°53.90'S, 154°00.33'E, 560 m, 30.iii.1983, R. Morton (Q.F.S.); QM W10570, 2 ♀ juv. (22.4, 24.0 mm), ♀ (67.8 mm), ♂ (72.1 mm), 26.0 n. miles off Pt Danger, 400m, 15.xii.1982, G. Smith (Q.F.S.); QM W10569, ♂ (85.8 mm), trawled M.V. 'Iron Summer', 27°56'S, 153°54'E, 590 m, 30.xi.1982, S. Hyland (Q.F.S.); QM W10567, ♀ (77.5 mm), trawled M.V. 'Iron Summer', 27°15.33'S, 153°54.01'E, 535 m, 31.iii.1983, R. Morton (Q.F.S.); QM W10566, ♂ (85.0 mm), trawled M.V. 'Iron Summer', 27°53.9'S, 154°0.33'E, 560 m, 30.iii.1983, R. Morton (Q.F.S.); QM W10568, ♀ (60.2 mm), trawled M.V. 'Iron Summer', 27°18'S, 153°54'E, 540 m, 13.viii.1982, G. Smith and J. Burke (Q.F.S.); QM W10565, ♂ (juv., 22.5 mm), ♂ (89.4 mm), trawled M.V. 'Iron Summer', 27°55'S, 154°01'E, 555 m, 30.xi.1982, Q.F.S.; QM W10564, ♀ (65.8 mm), trawled M.V. 'Iron Summer', 27°54'S, 153°58'E, 490 m, 30.xi.1982, S. Hyland (Q.F.S.); QM W10563, ♀ (66.1 mm), trawled M.V. 'Iron Summer', 27°13-22'S, 153°E, 500-540 m, M. Holmes (Q.F.S.).

DISTRIBUTION

Eastern Australia (from southeast Queensland to Victoria) and northern New Zealand.

***Parathranites orientalis* (Miers, 1886)**

Lupocyclus (*Parathranites*) *orientalis* Miers, 1886, p.186, pl.17, figs 1a-c.

Parathranites orientalis: Alcock, 1899a, p.17; Sakai, 1936, p.119, pl.32, fig. 2; 1939, p.376, fig. 2; 1965, p.113, pl.51, fig. 1; 1976, p.332, pl.113, fig. 3; Barnard, 1950, p.148, figs 29i-l; Stephenson, 1961, p.97, figs 1B, 2H, pl.1, fig. 2, pl.4B; Crosnier, 1962, p.22, fig. 24; Serène and Lohavanijaya, 1973, pp.59-60, pl.XIII, fig. A.

MATERIAL EXAMINED

QM W10598, 2 ♂ (24.6, 27.9 mm), trawled M.V. 'Iron Summer', 27°41.7'S, no longitude, 260 m, 10.vi.1983, P. Dutton (Q.F.S.); QM W10599, ♂ (24.0 mm), trawled M.V. 'Iron Summer', 27°35'S, 153°50'E, 210 m, 15.xii.1982, G. Smith (Q.F.S.).

DISTRIBUTION

Madagascar, Seychelles, India, Andamans, Kii Is., Japan, Admiralty Is., eastern Australia (off SE. Qld and Port Stephens, N.S.W.) and Solomon Bank.

Family GERYONIDAE

***Chaceon bicolor* Manning and Holthuis, 1989**

Chaceon bicolor Manning and Holthuis, 1989, pp.55-57, figs 3, 4.

Geryon affinis: Griffin and Brown, 1976, pp.256-7, figs 7-9; Sakai, 1978, pp.9-11, figs 18-19, pl.2, fig. D; [not *Geryon affinis* A. Milne Edwards and Bouvier, 1894].

Geryon quinquedens: Guinot and Richer de Forges, 1981c, p.249 [not *Geryon quinquedens* Smith, 1879].

MATERIAL EXAMINED

QM W10572, 2 ♀ (128.2, 140.6 mm), trawled M.V. 'Iron Summer', 27°13.69'S, 153°54.93'E, 600 m, 31.iii.1983, R. Morton (Q.F.S.); QM W10573, ♀ (159.7 mm), trawled M.V. 'Iron Summer', 27°59.37'S, 154°00.12'E, 590 m, 31.iii.1983, Q.F.S.; QM W10574, ♂ (162.9 mm), trawled M.V. 'Iron Summer', 27°S, 153-4°E, 31.iii.1983, Q.F.S.

DISTRIBUTION

Central Pacific: Emperor Seamount Chain in Japan; New Caledonia; and south to Sydney off eastern Australia.

Family GONEPLACIDAE

***Intesius pilosus* Guinot and Richer de Forges, 1981**

Intesius pilosus Guinot and Richer de Forges, 1981b, pl.VII, 1, 1a, 1b; 1981c, pp. 253-6, fig. 6D, 11A-G.

MATERIAL EXAMINED

QM W12401, ♀ (19.0 mm), trawled 'Nimbus' 27°00'S, 153°39'E, 183 m, 28.vii.1968, A.J. Bruce.

REMARKS

Our specimen differs slightly from the holotype in having the accessory spinules on the anterolateral spines not as strongly marked and the second anterolateral spine set slightly closer to the first (the outer orbital tooth). These differences may be size related as the present specimen is nearly half the size of the holotype male.

DISTRIBUTION

Loyalty Isles and now southeast Queensland, Australia.

ACKNOWLEDGEMENTS

We would like to thank the Queensland Fisheries Service and in particular Mike Potter and Mike Dredge for sending material to the Museum, and the latter for inviting one of us (P.D.) to accompany a trawling expedition on the 'Southern Intruder'. Mrs Helen Tranter allowed us to examine a number of majid specimens in the Australian Museum collections, and the manuscript has benefited from valuable discussions with her. Our warm appreciation is given for the valuable criticisms given by Dr Des Griffin of the Australian Museum, Dr Danièle Guinot of the Museum national d'Histoire naturelle, Paris, and Dr Bertrand Richer de Forges of O.R.S.T.O.M., Noumea. Thanks also to Mrs Peta Woodgate who typed the manuscript, and to Gary Cranitch who printed the photographs.

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ILLUSTRATED KEYS TO THE GENERA OF JUMPING SPIDERS (ARANEAE: SALTICIDAE) IN AUSTRALIA

VALERIE TODD DAVIES AND MAREK ŻABKA

Davies, V. Todd and Żabka, M. 1989 11 13: Illustrated keys to the genera of jumping spiders (Araneae: Salticidae) in Australia. *Mem Qd Mus.* 27(2): 189-266. Brisbane. ISSN 0079-8835.

From the keys, accompanying notes and illustrations 57 presently described genera of Australian salticids can be identified. Four genera, *Rhombonotus*, *Canama*, *Jotus* and *Prostheclina* have been reinstated. Three genera, *Harmochirus*, *Omoedus* and *Mintonia* are newly recorded from northern Australia. The following spiders are illustrated for the first time: ♂ *Canama hinnuleus*, ♂ *Cocalus gibbosus*, ♂ *Coccorchestes ferreus*, ♀ *Hypoblemum* sp., ♂ *Ligonipes* sp., ♂ *'Lycidas' michaelsoni*, ♀ *Moratus* sp., ♂ *Prostheclina pullida*, ♀ *Sandalodes bipenicillatus*, ♀ *'Trite' daemeli*, and ♂ *'Trite' longula*. *Discocnemius* Thorell, 1881 and *Haterius* Simon, 1900 are newly synonymised with *Ligonipes* Karsch, 1878, resulting in new combinations: *D. lacertosus* = *L. lacertosus* (Thorell, 1881) n. comb.; *H. semitectus* = *L. semitectus* (Simon, 1900) n. comb. The Australian *Pystira* spp. have been transferred to *Zenodorus* thus *P. orbiculata* = *Z. orbiculatus* (Keyserling, 1881) n. comb. and *P. obscurifemorata* = *Z. obscurifemoratus* (Keyserling, 1881) n. comb.

□ Key, Salticidae, jumping spiders, Australia.

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In Koch and Keyserling's (1871-1883) monumental three volume work, *Die Arachniden Australiens*, more than 150 species of jumping spiders, mostly from Australia, were described. The work was well illustrated and contained a key to 46 genera, based mainly on habitus, lengths of legs and arrangement of eyes. Because these volumes are rare it seems opportune to publish new illustrations of as many Australian genera as we can identify and to construct keys using more reliable characters. We recognise that many more genera and hundreds of species are yet to be described.

Subsequent accounts of the genera of jumping spiders have dealt with the salticid genera of the world. A historical review was given by Peckham and Peckham (1885). Finding some names were preoccupied, they provided several new generic names, including 5 for Australian spiders (see list of genera p. 191). They also gave a key to 84 genera, rather less than were then described because the descriptions on which their key was based were too incomplete for some genera to be included. Simon (1897-1903) separated the jumping spiders of the world into 3 major divisions depending on the retromarginal dentition of the chelicera — the Pluridentati with several teeth, the Fissidentati with a divided tooth and the Unidentati with a single tooth or none; the last is by far the largest group. Whether the system is artificial (Żabka believes that it is) or not, it seems to be a practical and sensible way to structure keys when

so few sub-families are sufficiently defined to be of use in this respect. It says much for Simon's analytical skill that these divisions, which he considered 'peut-être un peu artificielles', are still used. It is clear that within these divisions many natural groups of genera can be recognised. Simon (*loc. cit.*) gave keys to 'groupes' (some of which have since been recognised as sub-families) and within the 'groupes' he gave keys to genera. These keys, in association with the illustrations from Koch and Keyserling (*loc. cit.*) are the main basis for the identification of genera in Australia today. Petrunkevitch (1928) recognised and gave keys for 23 sub-families arranged, somewhat reluctantly, in Simon's three divisions; he listed the genera in the sub-families.

Chrysanthus (1968) redescribed and figured 20 salticid species from New Guinea, nearly all of which are also found in northern Australia. In recent revisions Wanless (1978, 1981, 1984a, 1984b) has redescribed and figured several Australian 'plurident' genera, culminating in his revision (1988) of the Astieae. This is the first and only comprehensive revision of a group of Australian salticids and in it he gives keys to genera and species.

Prószyński's (1984, 1987) recent atlases of specimens in European museums have been valuable. Żabka's (1987a, 1987b) drawings of some of the existing types are reproduced in this paper, along with other drawings from types and

many from fresh material. The key is divided into 3 sectional keys, the Pluridentati (16 genera), the Fissidentati (13 genera) and the Unidentati (28 genera). Short notes on the genera are given below the relevant part of the keys. Occasionally attention is drawn to the similarity between genera with different cheliceral dentition, suggesting that these are closely related e.g. *Harmochirus* (fissident) and *Bianor* (unident).

Many of the Australian spiders described by early workers were assigned to Northern Hemisphere genera to which they do not belong. In many cases this has been recognised and new names have been given or transfers made to other described genera. We recognise that several of the latter do not belong in these genera either. No new names have been supplied here as it is hoped that proper diagnoses and revisions of the genera will accompany such a move. The present names of seven such genera are placed in single inverted commas to indicate their indeterminate status e.g. '*Breda*' *jovialis*.

Salticids are seldom less than 2.0mm in length, most are between 4.0–8.0mm. Unlike most spiders the males often exceed the females in size. The lengths of spiders in the size classes used are as follows: 'small', less than 4.0mm; 'medium', 4.0–8.0mm; 'large', more than 8.0mm.

The following abbreviations are used: ALE, anterior lateral eyes; AME, anterior median eyes; PLE, posterior lateral eyes and PME, posterior median (or middle) eyes.

A glossary of most of the terms used may be found in Davies (1986). Other terms: 'fossa(e)', the single or paired epigynal indentation(s) within which the gonopores are situated; '*pars cephalica*', the anterior part of carapace, in front of PLE; '*pars thoracica*', the posterior part of carapace, behind PLE; 'ocular quadrangle', quadrangle formed by ALE and PLE; 'posterior ocular quadrangle', quadrangle formed by PME and PLE.

ILLUSTRATIONS

Figures and labels on Plates 1 and 2 show the general structure of salticids and introduce the terminology used. The rest of the illustrations are an essential part of the keys and should be examined as these are worked through. In almost all instances, a dorsal view of the ♀ is drawn and often a lateral view of the carapace to show height. A ventral view and a 'cleared' view of the epigynum are given. The latter may be ventral, dorsal or a combination of both views; sometimes a schematic drawing showing the course of the insemination ducts to spermathecae and to fertilization ducts is included. The ♂ habitus is occasionally drawn;

ventral and retrolateral views of the left palp of the ♂ are given. Leg 1 and a chelicera of the ♂ and ♀ may be drawn. The labium and endite(s) are illustrated if they are diagnostic. Usually only structures that do not appear in Plates 1 or 2 are labelled in subsequent Plates. An asterisk following the name of the species on the Plate indicates it is the type species of the genus. The drawings were done by Žabka using a grid system; some additional illustrations were done by Sybil Monteith using a *camera lucida*.

APPENDIX

An appendix gives the geographical localities of the specimens that have been drawn. Where a 'type specimen' has been examined the initials of the Museum where it is deposited is given.

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We are grateful to Dr M. Gray for use of several spiders from the Australian Museum (AM), and the following colleagues for allowing examination of types in their collections: Mr F. Wanless and Mr P. Hillyard, British Museum of Natural History, London, England (BMNH); Dr G. Rack, Zoologisches Institut und Zoologisches Museum, Hamburg, BDR (ZMH); Dr J. Heurtault, Museum National d'Histoire Naturelle, Paris, France (MNHP); Dr M. Moritz, Museum für Naturkunde der Humboldt — Universität, Berlin, DDR (ZMB); Dr S. Langemark, Zoologisk Museum, Universitetsparken, Copenhagen, Denmark (ZMK); Dr Arbocco, Museo Civico di Storia Naturale, Genoa, Italy (MCG).

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We are grateful to Mr F. Wanless who made helpful comments on the keys at an early stage and to Professor N.I. Platnick and Mr Bruce Campbell who read, made corrections and suggested improvements to the final manuscript.

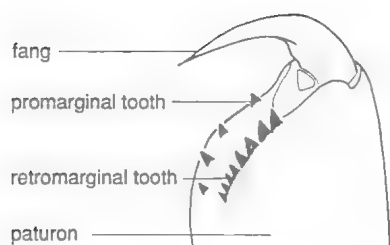
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KEY TO FAMILY SALTICIDAE

The family is divided into 3 sections, based on the dentition of the inferior (retro-) margin of the chelicera (Plate 1). Separate keys are then given for each section.

1. Retromargin of chelicera with many teeth, isolated or in series(p.194) PLURIDENTATI
- Retromargin of chelicera with one tooth
2. Cheliceral tooth with 2 cusps, rarely truncated or serrulate(p.214) FISSIDENTATI
- Cheliceral tooth simple, occasionally absent(p.230) UNIDENTATI



Pluridentati

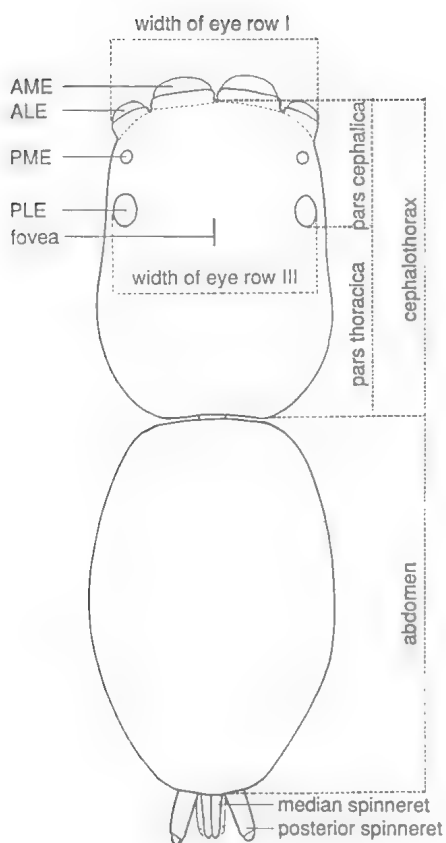


Fissidentati

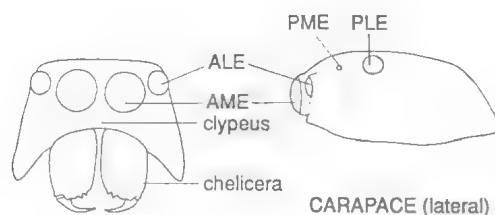


Unidentati

CHELICERAE (ventral)

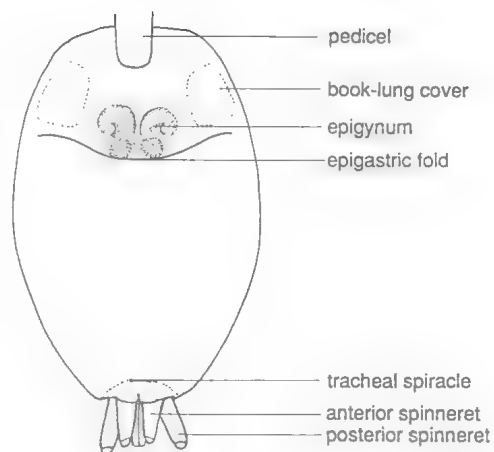


♀ (dorsal)



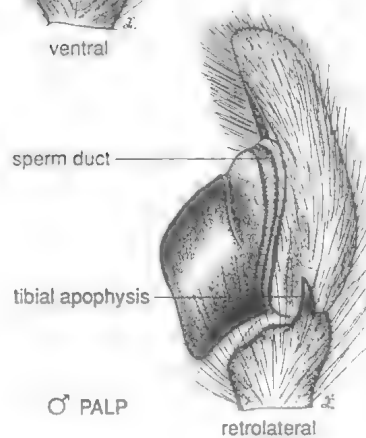
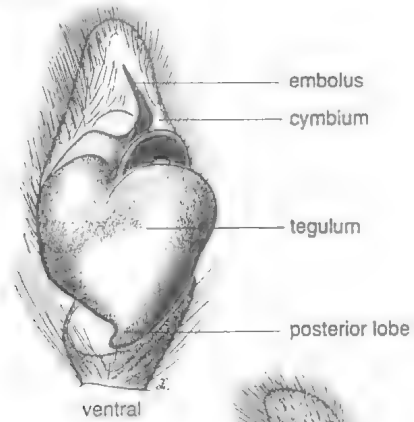
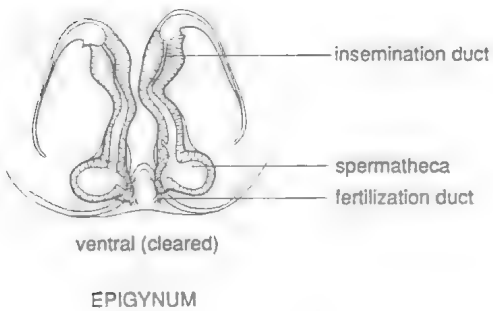
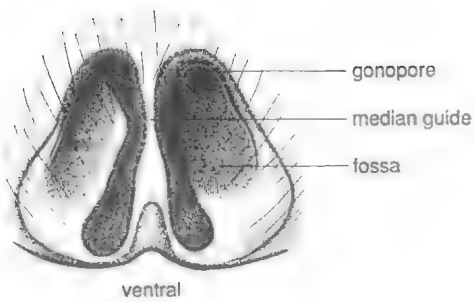
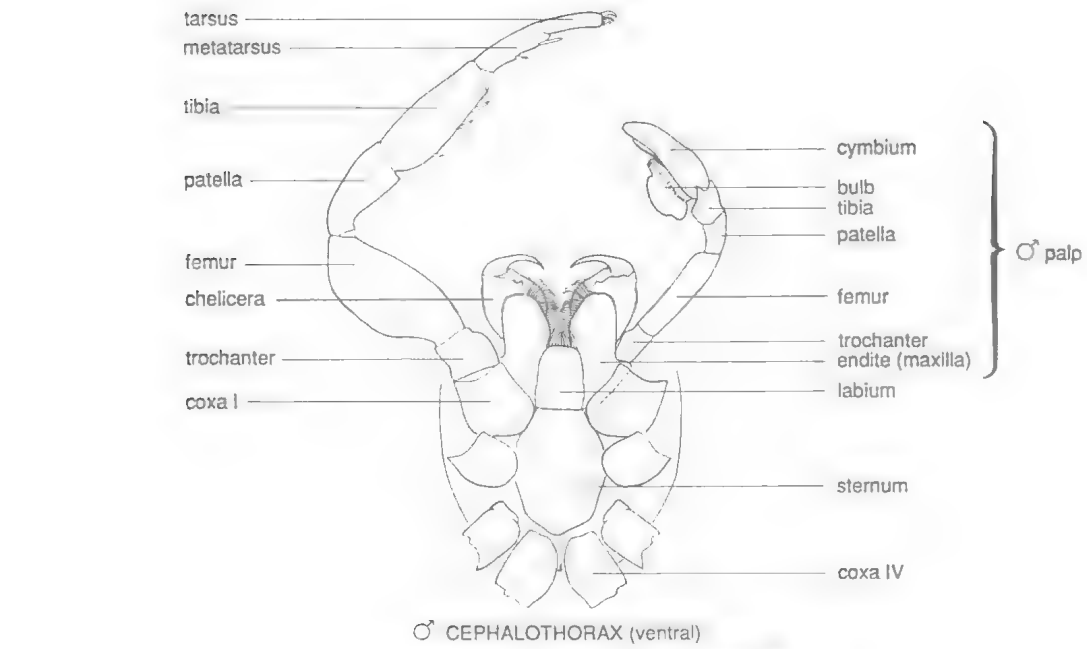
CARAPACE (lateral)

HEAD (frontal)



♀ ABDOMEN (ventral)

1. MORPHOLOGY OF SALTICIDAE



2. MORPHOLOGY OF SALTICIDAE

PLURIDENTATI — KEY TO GENERA

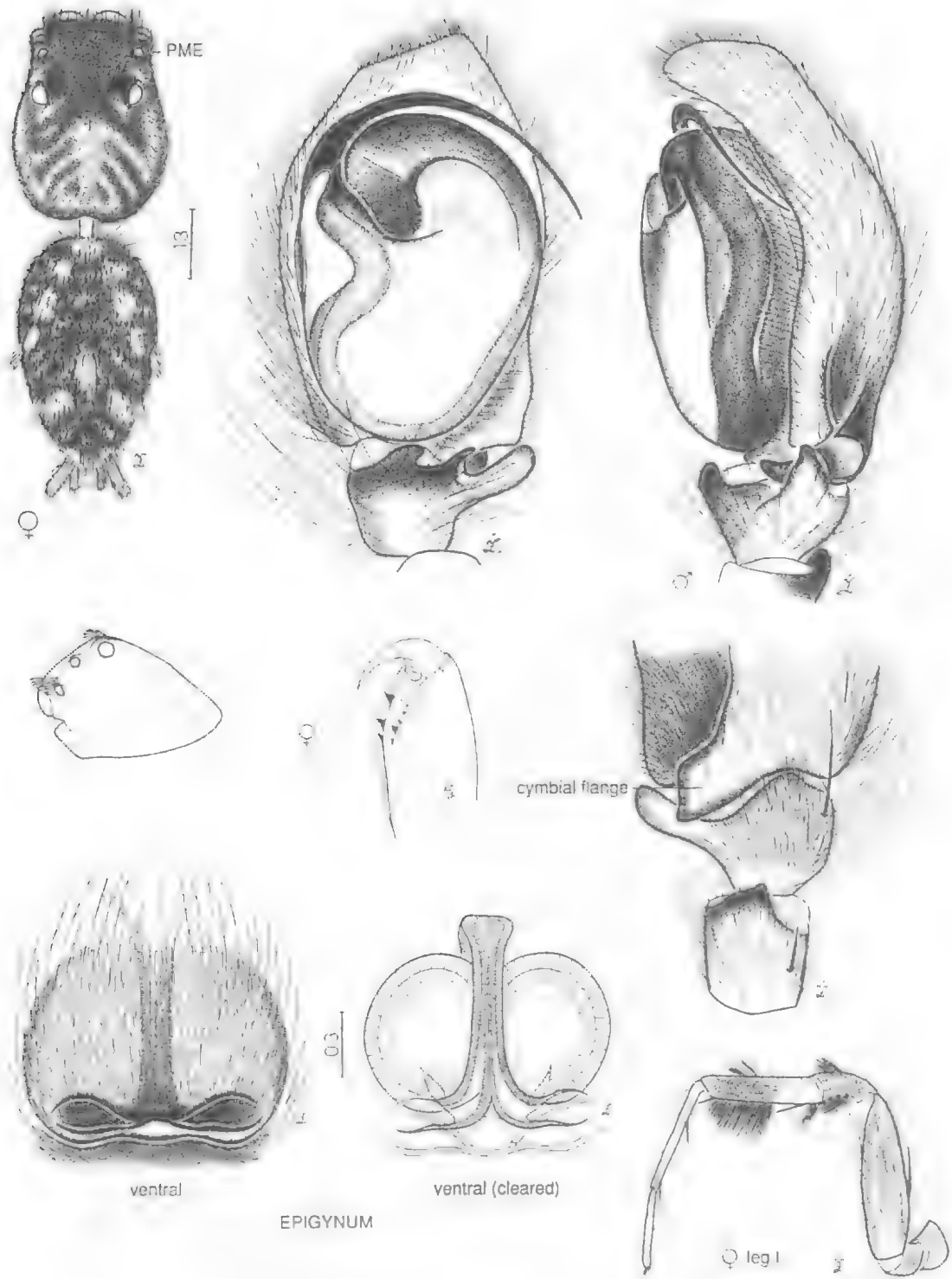
1. Middle eyes (PME) relatively large; *pars cephalica* rising steeply to high point at level of PLE .. 2
- Middle eyes small; *pars cephalica* flat or rising gradually 4
2. Abdomen with tufts of hair; legs with fan-like fringes (Pl. 3) *Portia*
(northern Australia)
- Abdomen without tufts of hair; legs without obvious fringes 3
3. Small, low prominence in posterior ocular quadrangle (Pl. 4) *Cocalus*
(northern Queensland)
- Without small prominence in posterior ocular quadrangle (Pl. 5) *Mintonia*
(northern Queensland)
4. Thoracic fovea unusually long. ♀ epigynum with notched posterior margin (Pl. 6) *Cyrba*
(introduced)
- Thoracic fovea not unusually long. ♀ epigynum otherwise 5
5. Spiders ant-like. Carapace at least 1.5 × longer than wide; widest part of carapace at or in front
of PLE. Abdomen slightly constricted in the anterior third 6
- Spiders not ant-like. Carapace not much longer than wide (exc. *Copocrossa*); widest part of carapace
behind PLE. Abdomen not constricted 9
6. ♀ and ♂ tibia I heavily fringed 7
- ♀ and ♂ tibia I unfringed or very lightly fringed 8

Wanless (1978b) gives synonymies of *Portia* and *P. fimbriata*. There is an excellent coloured photograph of *P. fimbriata* in Jackson (1985a) showing its strange habitus particularly its tufted tibiae and thin elongate metatarsi and tarsi. At rest, in other spiders' webs, it resembles detritus. Reports of *Portia* spp. entering other spiders' webs are documented in Wanless (*loc. cit.*). Coleman (1978) and Murphy (in Wanless 1978b) appear to have been the first persons to observe the web-building of this highly specialised salticid. The biology of *P. fimbriata* has since been extensively studied by Jackson (1982a) and others. Williams and McIntyre (1980) showed that the anterior median eyes of *P. fimbriata* have a telephoto component enabling it to increase the image size and thus assist in the stalking and catching of prey. For further references on behaviour see Jackson and Hallas (1986a).

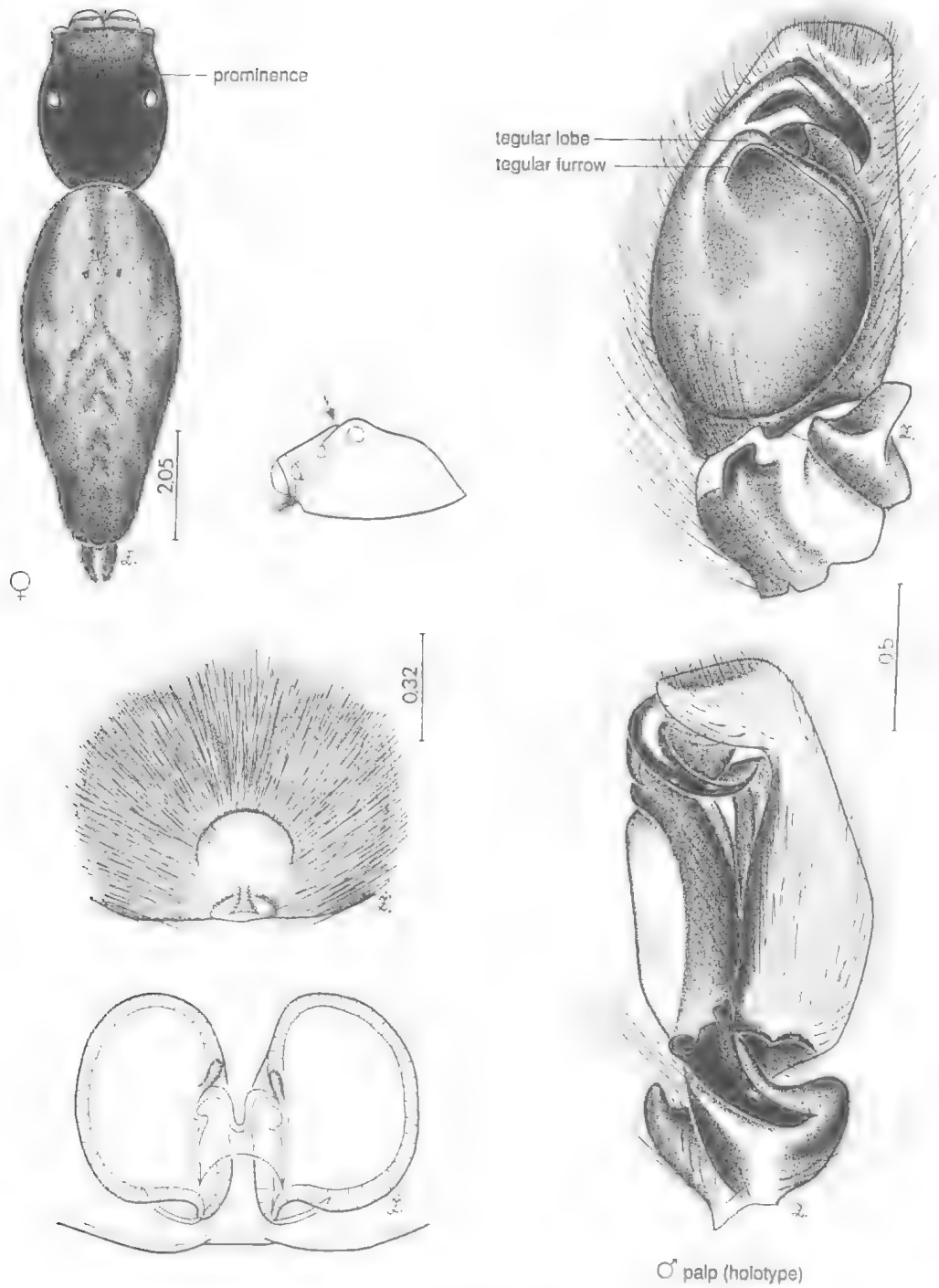
Wanless (1981) revised *Cocalus* and described ♂ *C. gibbosus*. The ♀ is figured here for the first time. *Opisthoncus*, a fissident spider, also has a small prominence in the posterior ocular quadrangle, and occasionally it has plurident dentition; the structure of the ♂ palps and ♀ epigyna easily distinguish the genera.

Mintonia is recorded from Australia for the first time. To give some idea of the ♂ palp, drawings of *M. tauricornis* from Sarawak have been copied from Wanless (1984a).

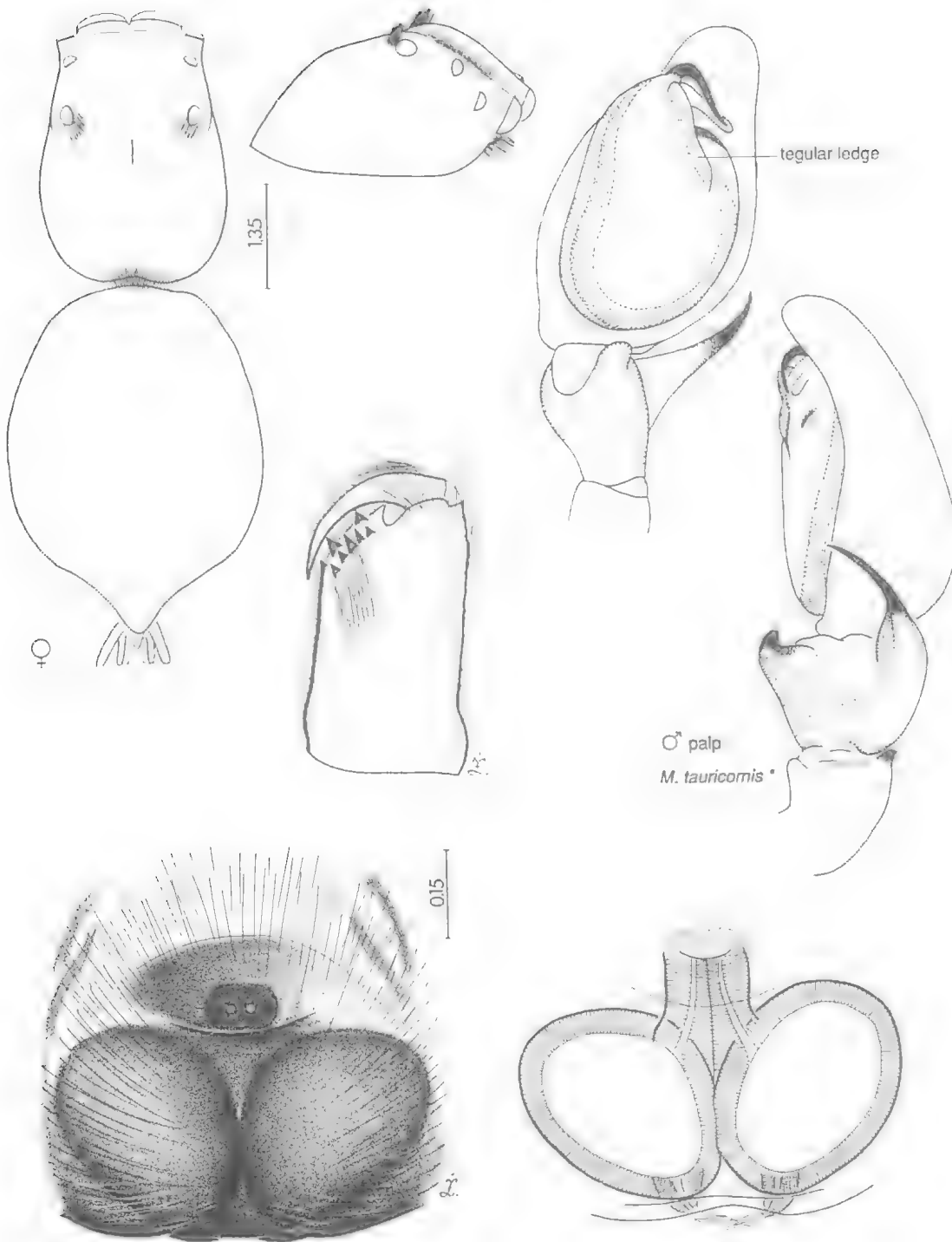
See Wanless (1984b) for synonymies of *Cyrba* and *C. ocellata*. In his revision Wanless (*loc. cit.*) gives excellent micrographs of the abdominal secretory organs of *Cyrba* spp. and discusses their possible significance. Jackson and Hallas (1986b) give behavioural data on *C. algerina*, which probably applies to all *Cyrba* spp. As well as being an effective cursorial predator of insects it invades other spiders' webs to eat them, their eggs and their kleptoparasites. *Portia*, *Cocalus*, *Mintonia* and *Cyrba* are among those that Wanless (1984a) has assigned to the sub-family Spartaestinae.



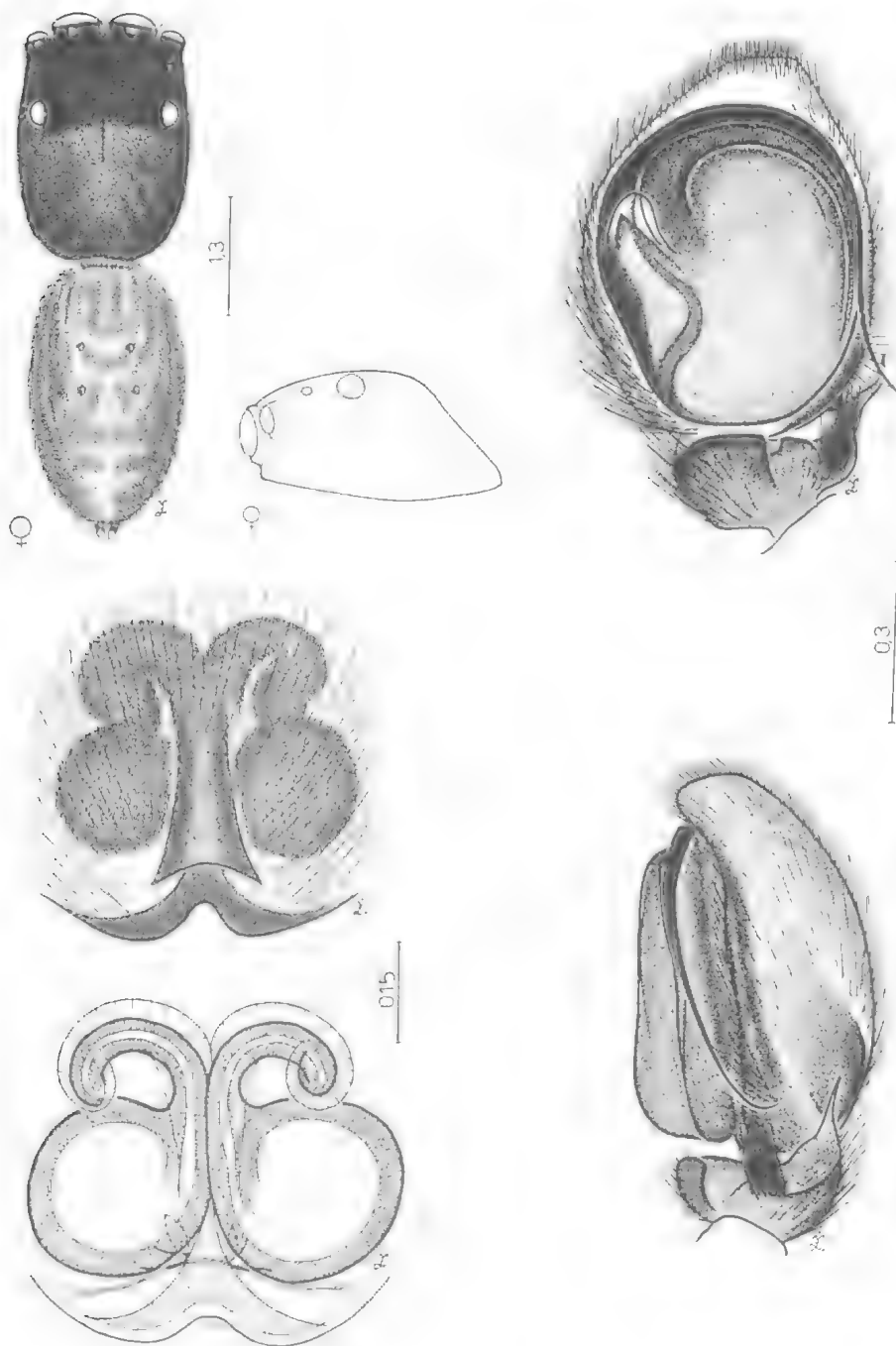
3. PORTIA FIMBRIATA (DOLESCHALL, 1859)

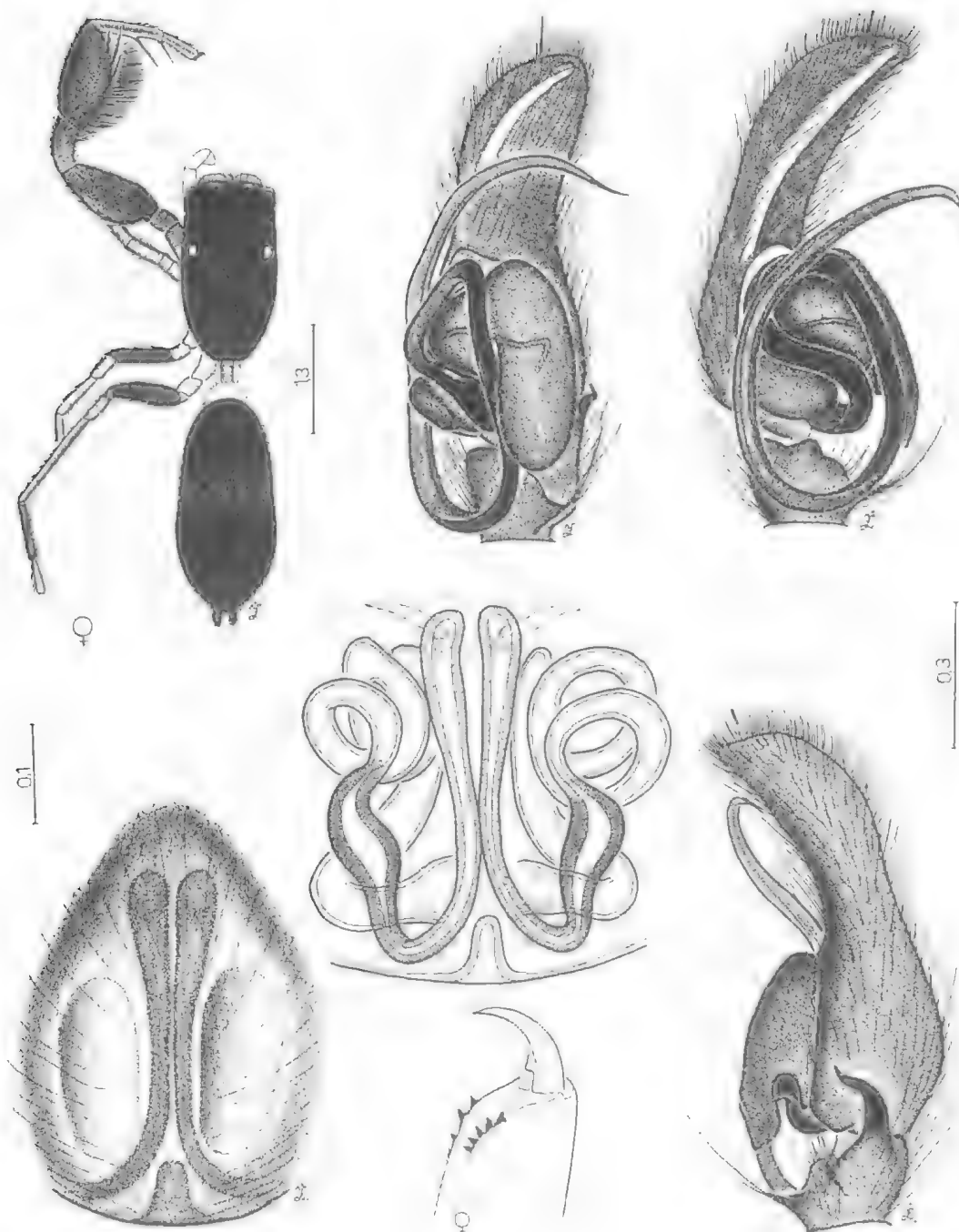


4. COCALUS GIBBOSUS WANLESS, 1981



5. MINTONIA SP. loc. Kuranda, northeast Queensland

6. *CYRBA OCELLATA* (KRONEBERG, 1875)



7. *LIGONIPES* SP. loc. Brisbane, southeast Queensland

7. Middle eyes about same distance from anterior and posterior rows; PLE not on edge of carapace, about same distance apart as ALE. Ratio of *pars cephalica:pars thoracica* is 1:1.1. ♀ insemination ducts coiled (Pl. 7,8) *Ligonipes*
(*Discocnemius* n.syn. *Haterius* n.syn.)
- Middle eyes closer to anterior than posterior row; PLE on edge of carapace, more widely separated than ALE. Ratio *pars cephalica:pars thoracica* is 1:0.5. ♀ insemination ducts simple (Pl. 9) *Rhombonotus*
8. ♀ palp flat, paddle-shaped. ♂ chelicerae porrect, elongate. Marked drop in carapace height behind PLE. Leg IV longest (Pl. 10) *Myrmarachne*
- ♀ palp leg-like. ♂ chelicerae geniculate, bowed. Without marked drop in carapace height behind PLE. Leg I longest (Pl. 11) *Damoetas*
9. Small, flat spider; leg I much longer than leg II; tibia I enlarged (Pl. 12) *Copocrossa*
(♂ unknown)
- Small-large spiders. Leg I not much longer than leg II; tibia I not enlarged 10

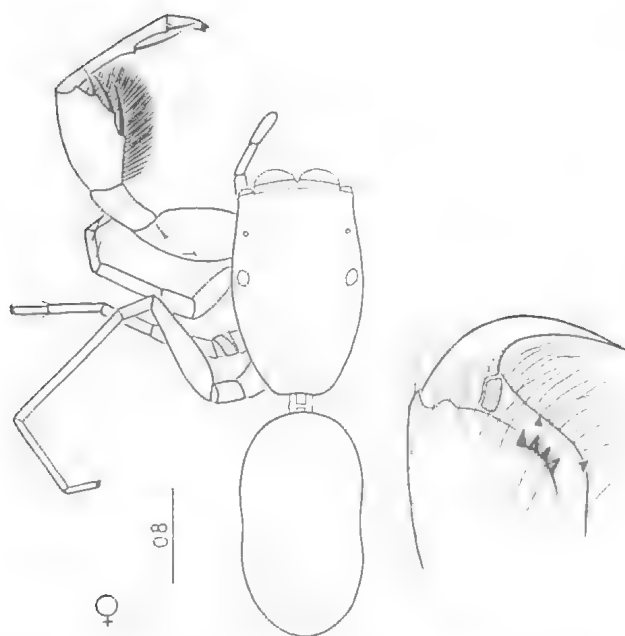
The 4 plurident ant-mimics *Ligonipes*, *Rhombonotus*, *Myrmarachne* and *Damoetas* form part of a natural group, the Myrmarachninae. The ♀ holotype of *L. illustris*, type species of *Ligonipes* is very fragile and has not been dissected. Prószyński (1984: 158) illustrates the habitus. The species drawn here is probably not *illustris*, *s.strict*; ♂ *Ligonipes* is illustrated for the first time. *Discocnemius* Thorell, 1881 and *Haterius*, Simon 1900 are newly synonymised with *Ligonipes* Karsch 1878, resulting in new combinations: *D. lacertosus* = *L. lacertosus* (Thorell, 1881) and *H. semitectus* = *L. semitectus* (Simon, 1900). The former is drawn from fresh material from the type locality, see also Prószyński (1984: 35); the latter is drawn from ♀ syntype. The reasons for the synonymies are the possession of fringed and swollen tibiae I, the length and position of the ventral spines on metatarsus I, the position of the PME and the similarity of the ♀ epigynal structures. *L. lacertosus* and *L. semitectus* may be conspecific.

Rhombonotus Koch, 1879 was synonymised with *Ligonipes* by Simon (1897-1903: 493). It is reinstated as a valid genus differing from *Ligonipes* in habitus, eye arrangement and in having simple uncoiled insemination ducts in the ♀.

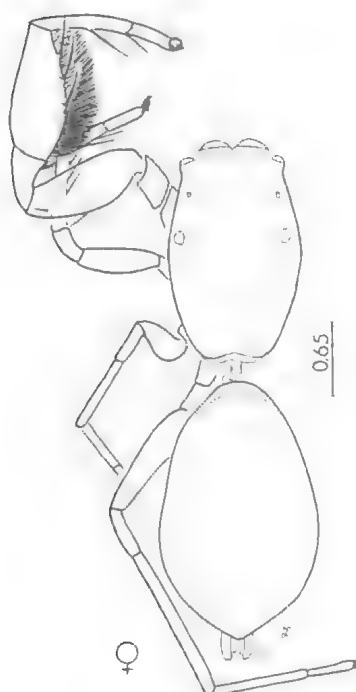
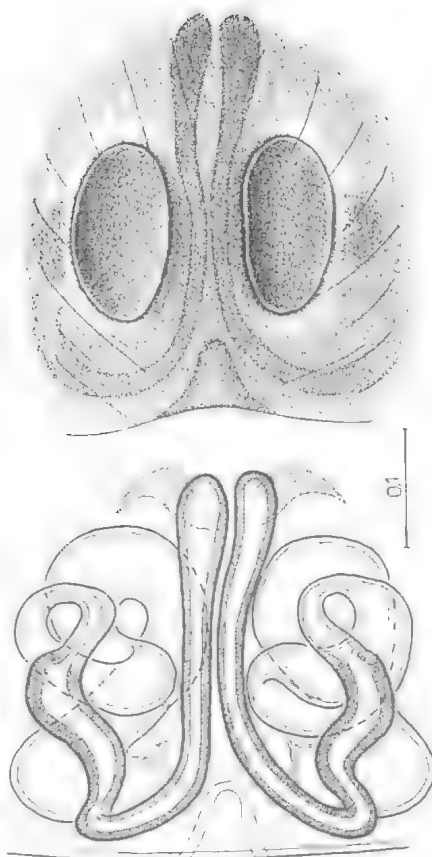
The ♂ *Myrmarachne* has strongly developed porrect chelicerae in contrast to the geniculate chelicerae of the ♀. The paddle-shaped ♀ palp is fringed with preening setae (Wanless, 1978a). Jackson (1982b, 1986a) discusses the biology of *M. lupata*, its display in courtship and mating, its prey and predatory behaviour.

The ♂ palp of *Damoetas nitidus* is drawn from the type (loc. Sydney). The other figures are from a ♂ collected in Brisbane which may not be *nitidus*, *s.strict*. The ♀ epigynum is from fresh material collected in Sydney.

The ♀ *Copocrossa* illustrated was collected from a cane field at Mission Beach, northern Queensland; it is almost certainly *C. tenuilineata*. The ♂ is unknown.

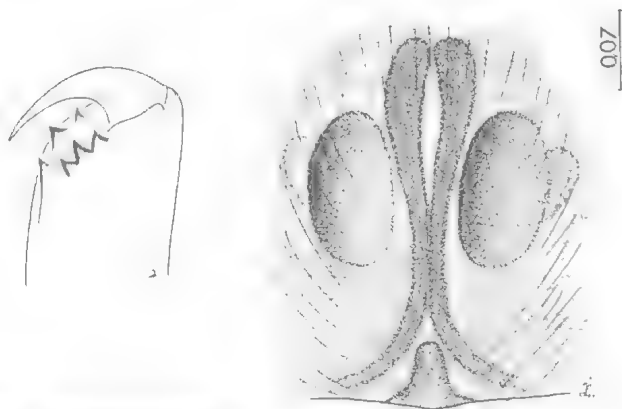


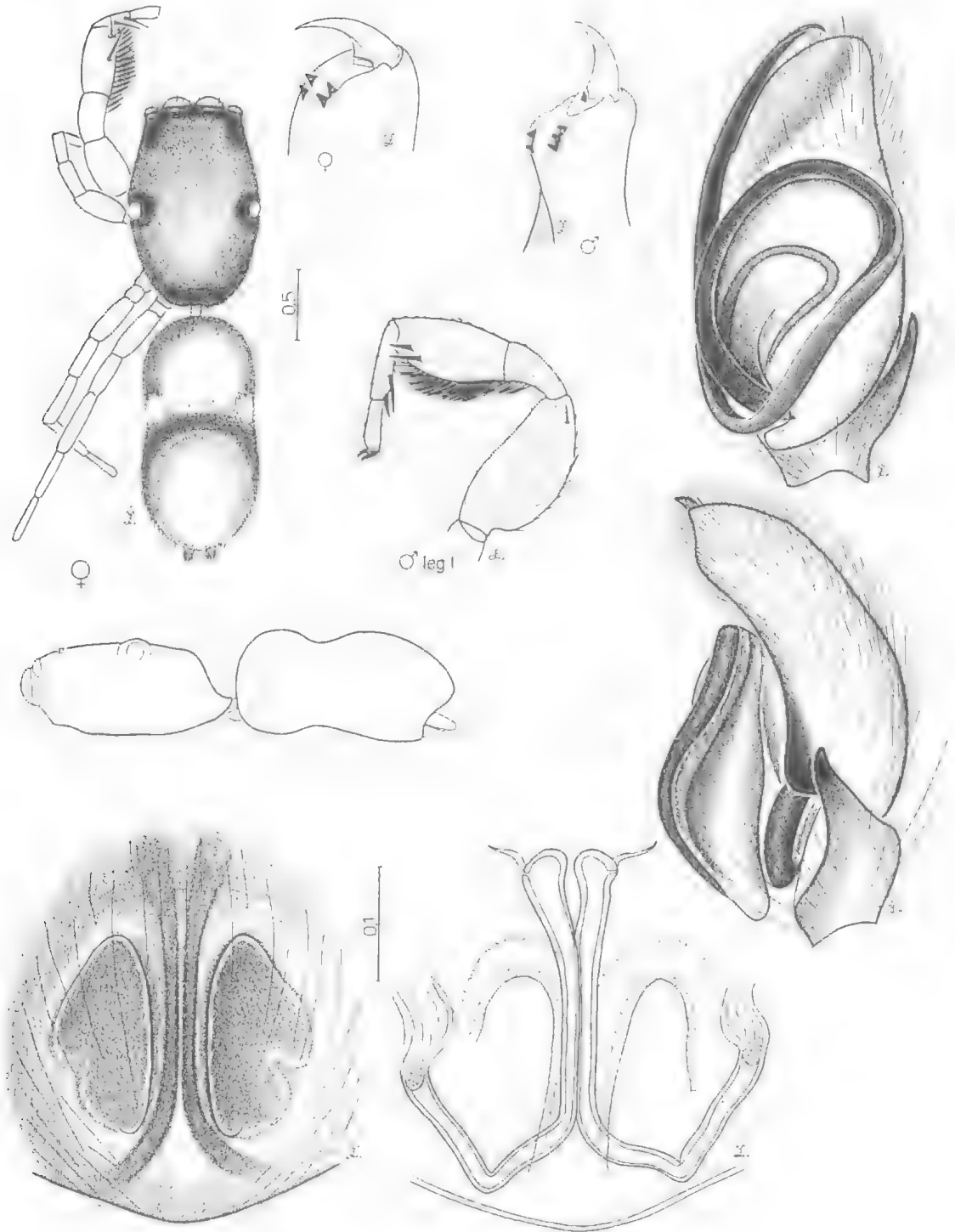
8A. *LIGONIPES LACERTOSUS* (THORELL, 1881)
N. COMB.

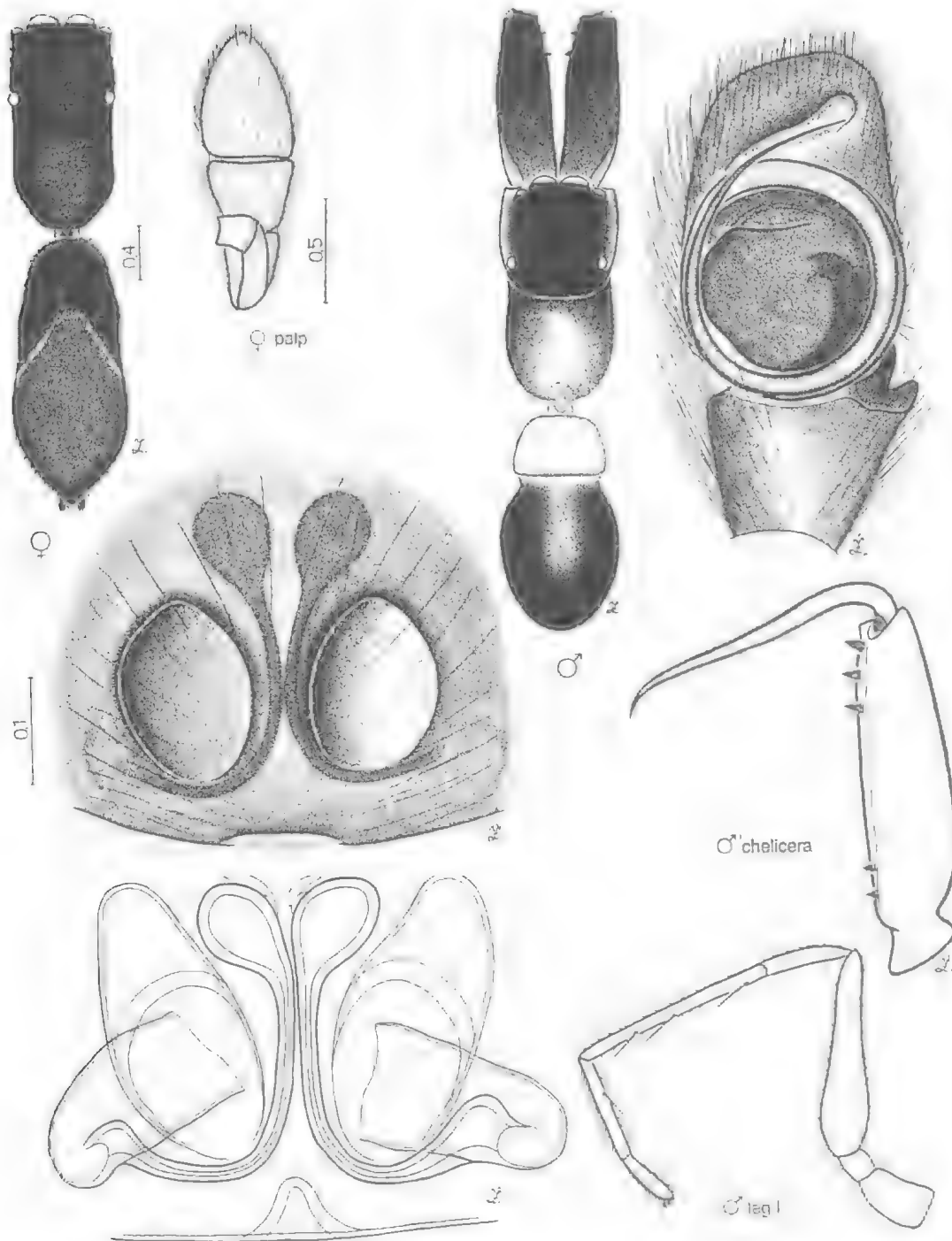


8B. *LIGONIPES SEMITECTUS* (SIMON, 1900) N. COMB.

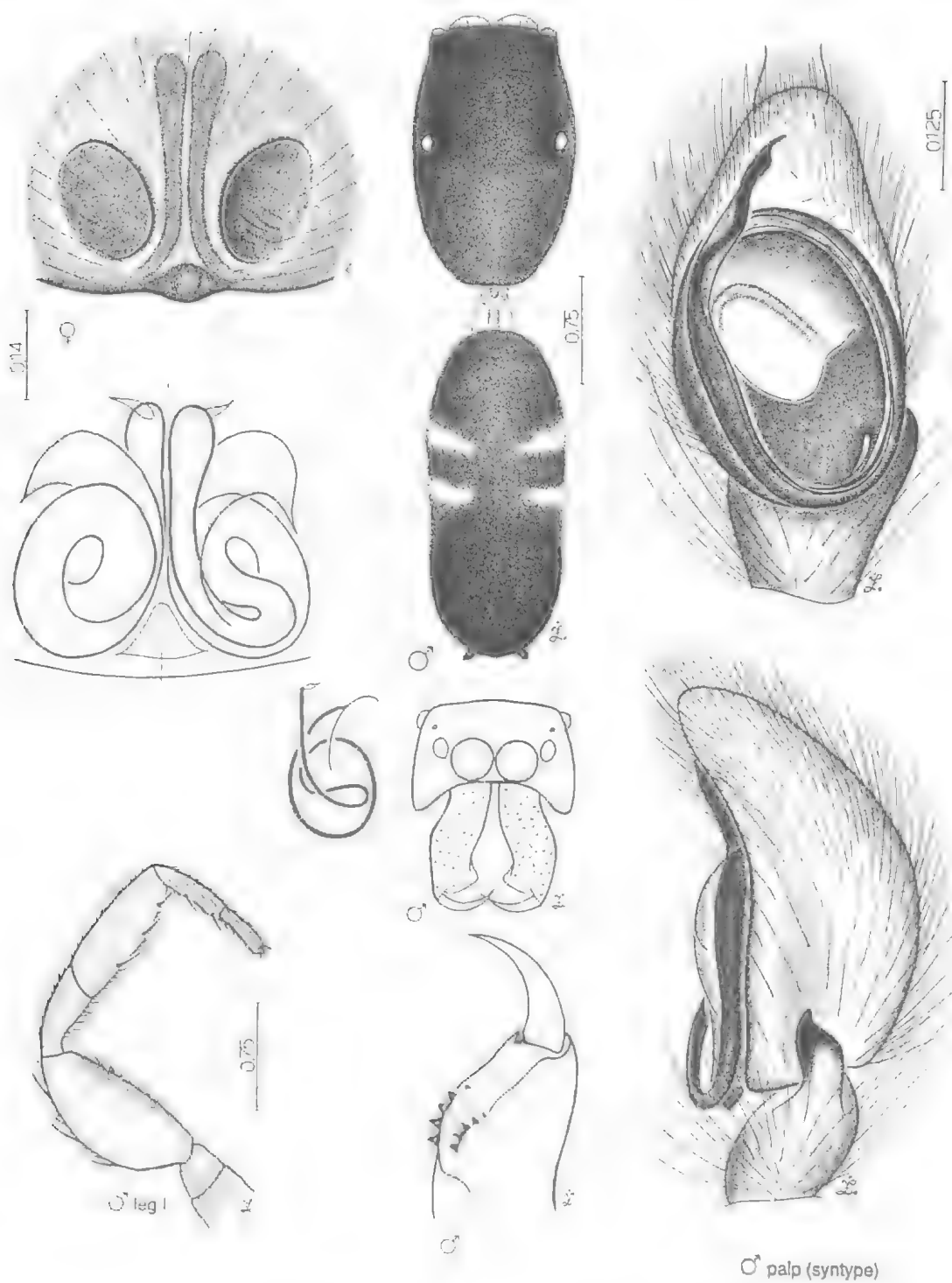
♀ (syntype of *Haterius semitectus*)



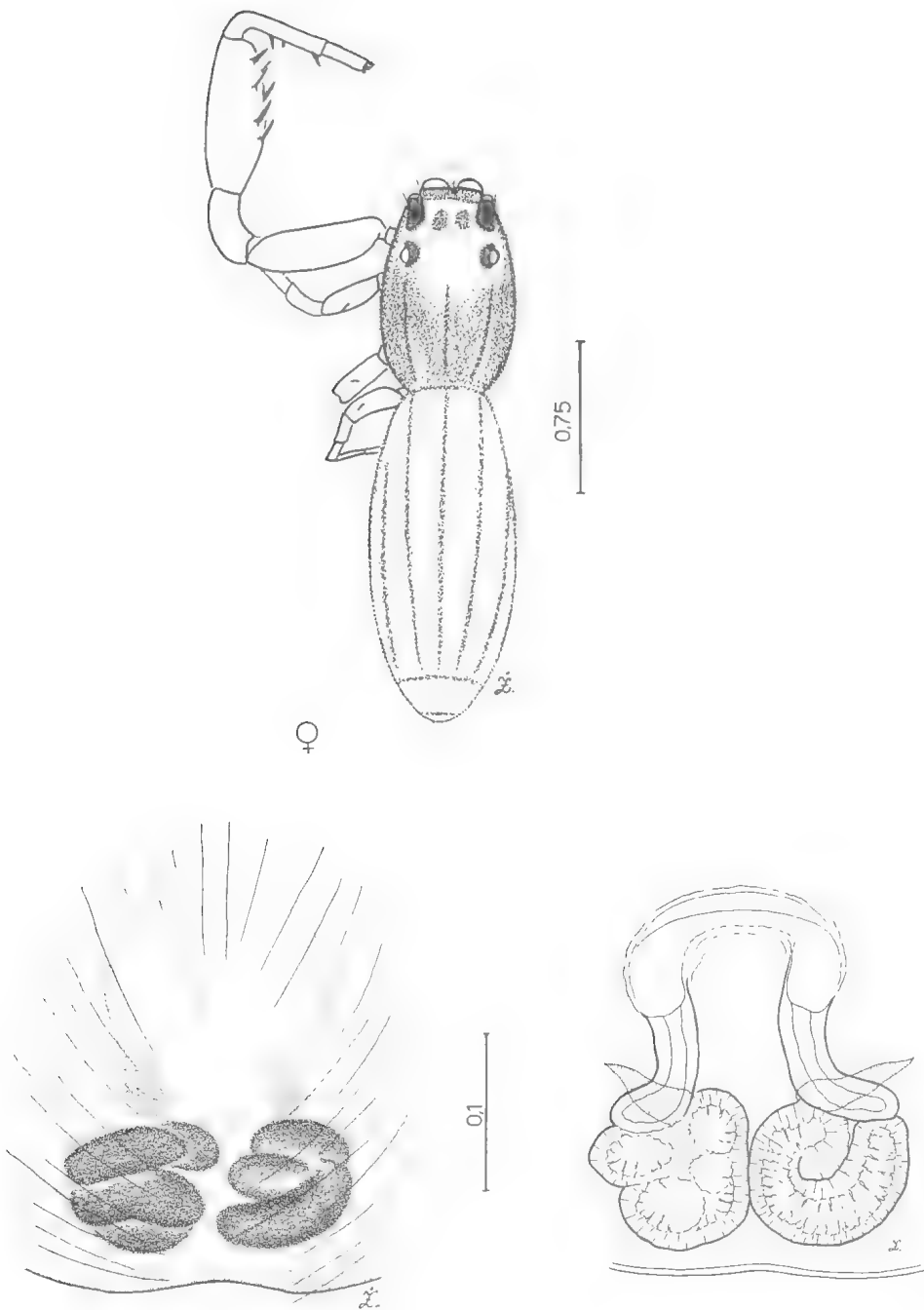
9. *RHOMBONOTUS GRACILIS* L. KOCH, 1879 *



10. MYRMARACHNE SPP. loc. ♀ Brisbane, ♂ Goomeri, southeast Queensland



11. DAMOETAS NITIDUS (L. KOCH, 1880) *

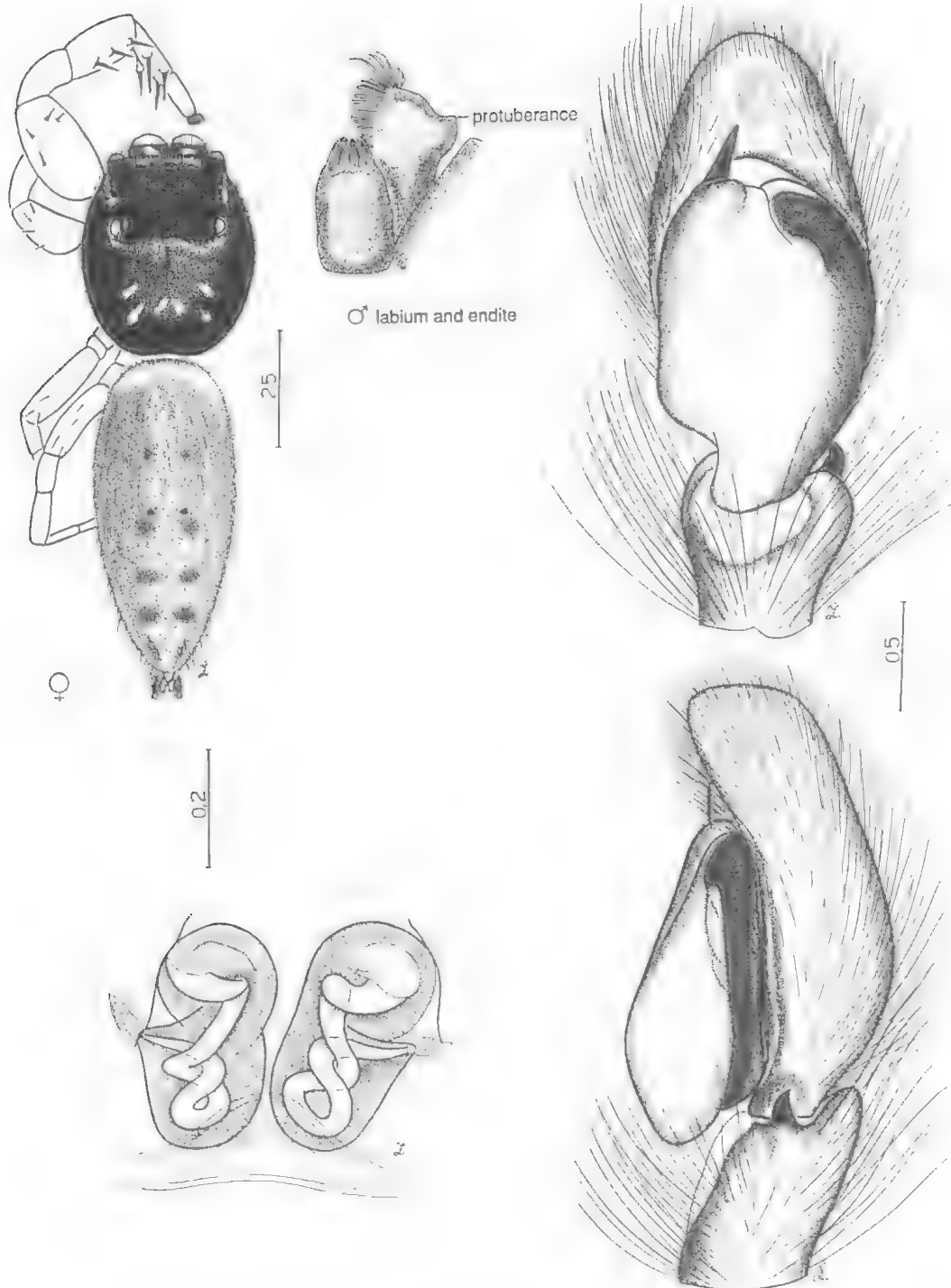


12. *COPECROSSA TENUILINEATA* (SIMON, 1900) *

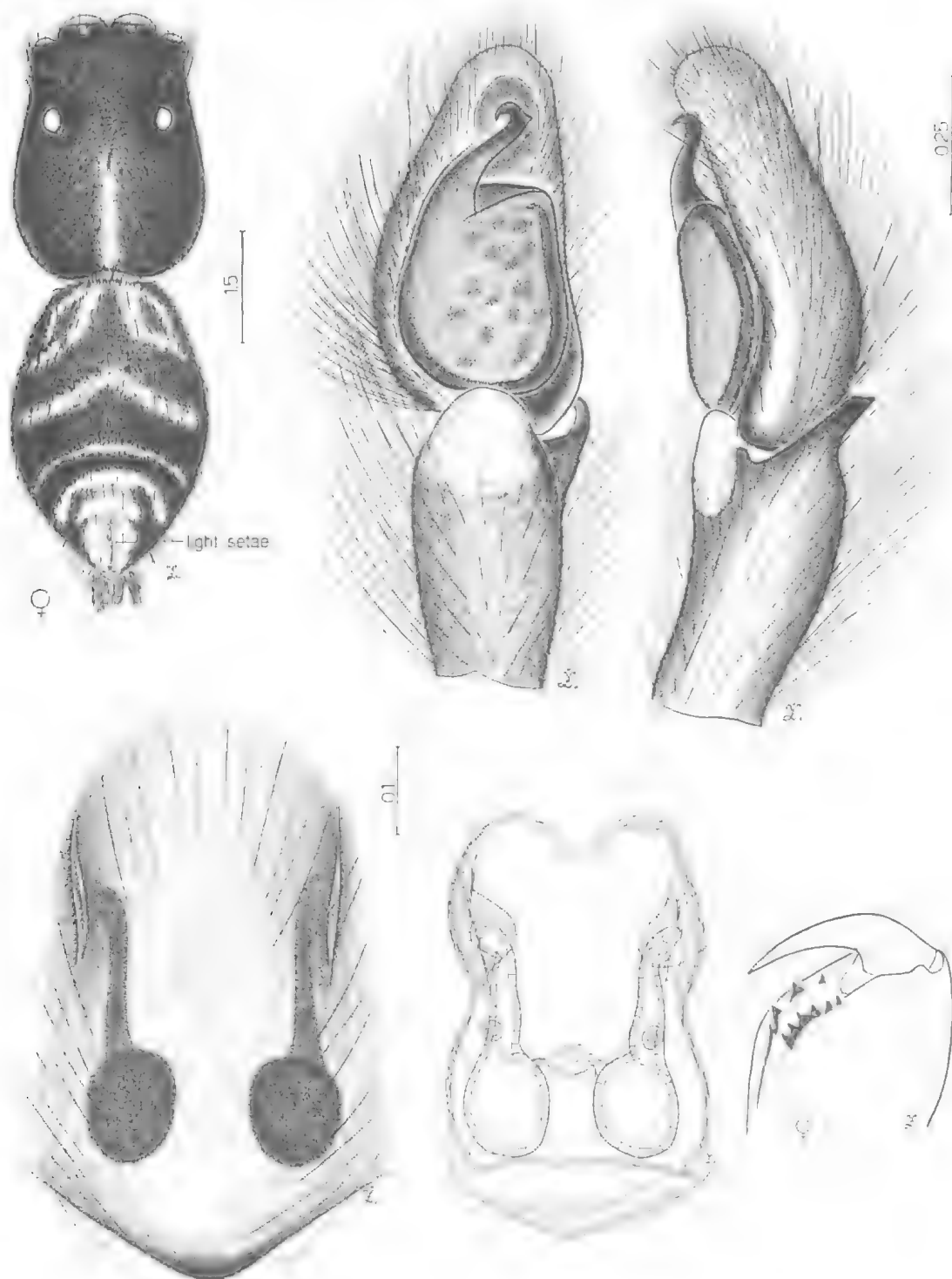
10. Large (10mm +) spiders. Labium about twice as long as wide. Retrolateral protuberance on ♂ endite (Pl. 13) *Bavia* (northern Australia)
 - Small and medium-sized spiders. Labium not much longer than wide. Without retrolateral protuberance on ♂ endite 11
11. Abdomen with conspicuous light dorsal patch of setae just anterior to anal tubercle (Pl. 14) *Astia*
 - Abdomen without conspicuous light dorsal patch of setae anterior to anal tubercle 12
12. Anterior surface of tracheal slit with patch of dark hairs; ♂ palp with minute embolus (Pl. 15) *Tauata*
 - Anterior surface of tracheal slit without patch of dark hairs; ♂ palp with small to elongate embolus 13
13. Carapace widest posteriorly, eye region small relative to carapace. Five pairs of ventral spines on tibia I (Pl. 16) *Arasia*
 - Carapace not widest posteriorly; eye region relatively large. Rarely more than 3 pairs of ventral spines on tibia I, never 5 pairs 14
14. Carapace with marked depression in foveal region emphasising prominence of PLE (Pl. 17) *Jacksonoides*
 - Carapace without marked depression in foveal region 15
15. Elongate spiders (especially ♂) with conspicuous transverse ocular fringe in ♂. ♂ tegulum with slight lobe posteriorly. ♀ epigynum with strong lateral margins and relatively large triangular pouch (sometimes difficult to see) (Pl. 18) *Helpis*
 - Habitus not elongate, without ocular fringe in ♂. ♂ tegulum without lobe, usually broad lamella near base of embolus. ♀ epigynum without strong lateral margins, without pouch; caudal lobe present (Pl. 19) *Sondra*

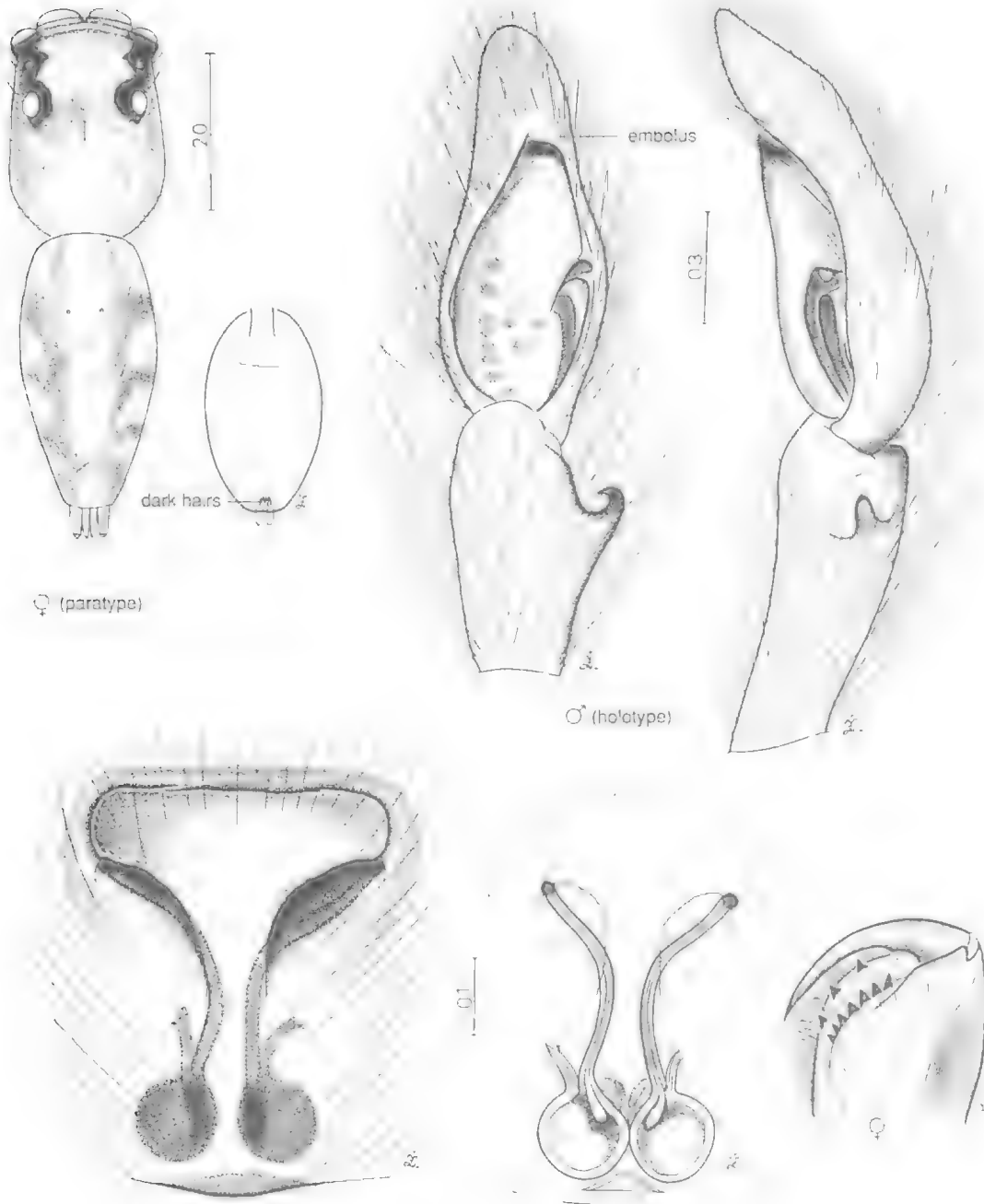
Simon (1897-1903: 470) recognised that the type species of *Acompse* Koch, 1879, *A. suavis*, was a junior synonym of *Bavia aericeps* Simon, 1877. *B. aericeps* is found on palms and other trees in tropical Australia. It appears to be un-related to other plurident spiders and to have its closest relatives among the large unident salticids, *Mopsus* and *Sandalodes*. Jackson (1986b) gives details of the display behaviour of the ♂ which varies depending on the maturity and location of ♀♀.

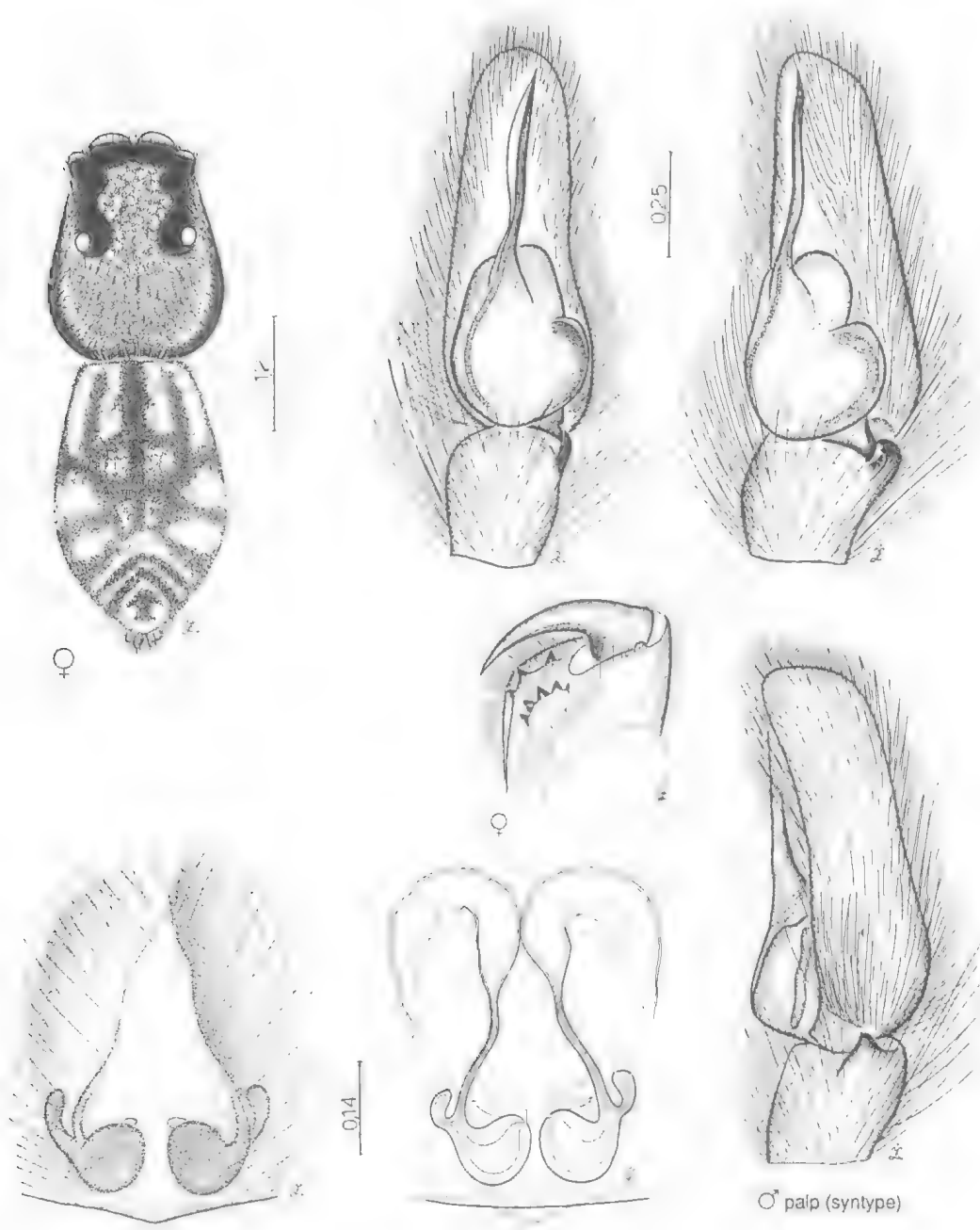
The next 6 genera, forming the Astieae, have been revised recently by Wanless (1988) and this part of the key is a simplified version of his. This is the only revision of a group of Australian salticids to be undertaken since the original description of *Astia* Koch, 1879 and Simon's (1897-1903: 438) subsequent transfer of 2 species as types of the genera, *Helpis* and *Arasia*. Mascord (1970, Pl. 10, fig. 36) shows ♀ *Astia hariola*. *Jacksonoides kochi* (Simon 1900), originally described as *Lagnus kochi*, is found on tree trunks in northern Queensland and is figured here; *J. queenslandicus* is the type species. *Astia*, *Arasia* and *Helpis* are found in open sclerophyll forests whereas *Jacksonoides*, *Tauata* and *Sondra* are from rainforest areas, the last from leaf litter. We believe that *Arasia aurea* does not belong in *Arasia* and probably represents a new genus. Jackson (1988a) reports that *J. queenslandicus* invades the webs of other spiders and has a large and complex repertoire of displays used in intra-specific interactions. Regrettably, his paper on the behaviour of *J. queenslandicus* was given page precedence in the same journal as Wanless' paper (1988) describing *Jacksonoides*. It is recognised as a *nomen nudum* in the former which is corrected in the latter. Jackson (1988b) gives an account of the behaviour of *Tauata lepidus* which spins its nest on the underside of leaves. Like *Portia*, *Cyrrba* and *Jacksonoides* it is araneophagic, kleptoparasitic and oophagic, i.e. it may enter other spiders webs to catch spiders, it may take insects from the webs, and as well eat the eggs of other spiders. *Sondra* is a large genus divided by Wanless into 4 species groups.



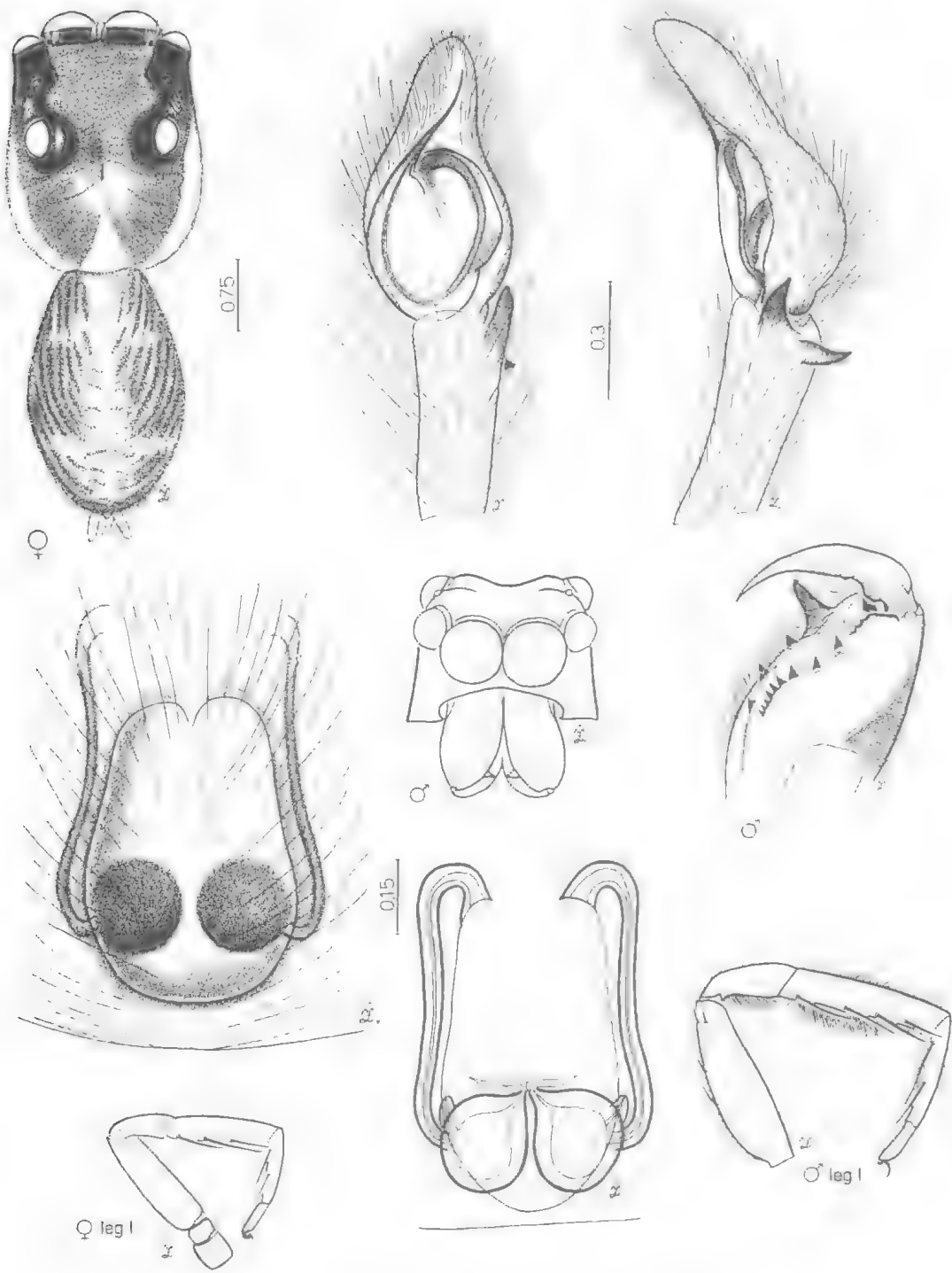
13. *BAVIA AERICEPS* SIMON, 1877 *

14. *ASTIA HARIOLA* L. KOCH, 1879 *

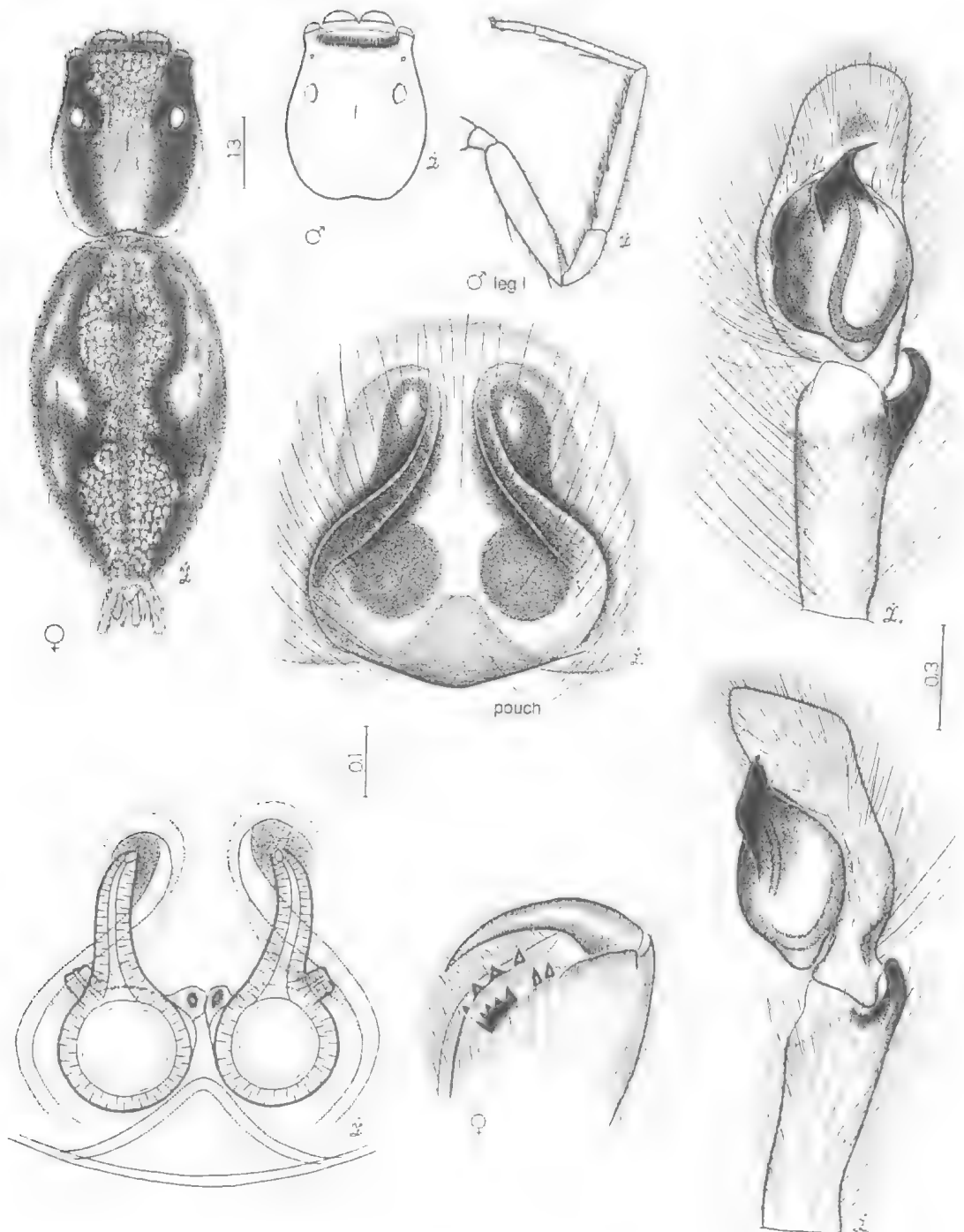
15. *TAUALA LEPIDUS* WANLESS, 1988 *

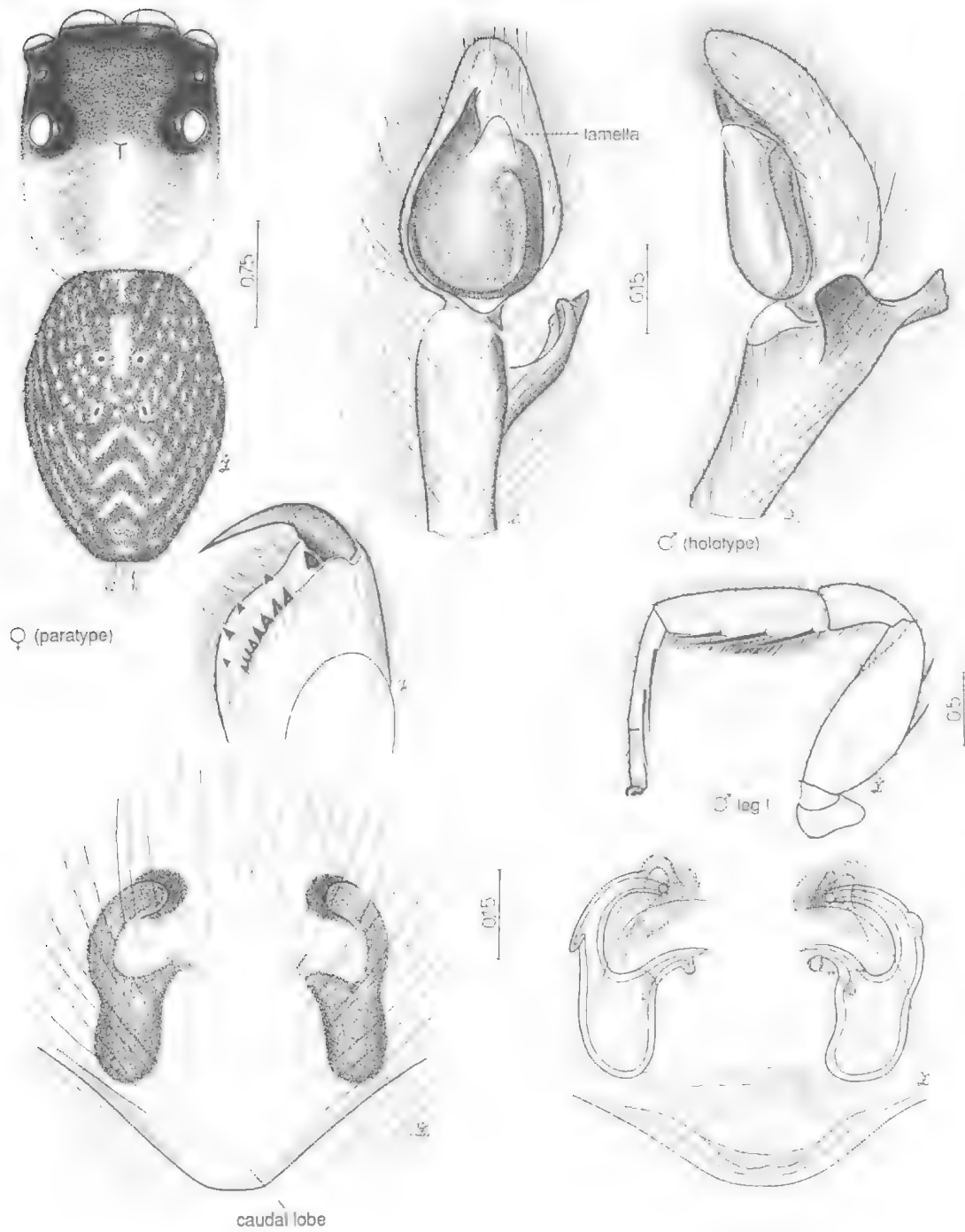


16. *ARASIA MOLLICOMA* (L. KOCH, 1880) *



17. JACKSONOIDES KOCHI (SIMON, 1900)

18. *HELPIS MINITABUNDA* (L. KOCH, 1880) *



19. *SONDRA NEPENTHICOLA* WANLESS, 1988 *

FISSIDENTATI — KEY TO GENERA

1. Coxa I almost twice or more as long as coxa II 2
- Coxa I slightly longer than coxa II 4
2. Carapace high and uneven; PLE on pronounced tubercles. ♂ and ♀ tibia I swollen with heavy fringing 3
- Carapace flat; PLE not on pronounced tubercles. ♂ tibia I not swollen, slight fringing (Pl. 20) *Tara* (♀ unknown)
3. Carapace wider than PLE (Pl. 21) *Diolenius* (northern Australia)
- Carapace narrower than PLE (Pl. 22) *Harmochirus* (northern Australia)
4. Small median prominence in posterior ocular quadrangle (Pl. 23) *Opisthoncus*
- Without median prominence in posterior ocular quadrangle 5
5. Ocular quadrangle clearly much wider behind than in front 6
- Ocular quadrangle equal or narrower behind 8
6. Trifurcate tooth on cheliceral retromargin of ♂. Short, thick embolus curved in anti-clockwise direction (left palp) Pl. 24 *Ergane* (♀ unknown)
- Bifurcate tooth on cheliceral retromargin of ♂, ♀. Long spiniform embolus if anti-clockwise, or embolus clockwise 7

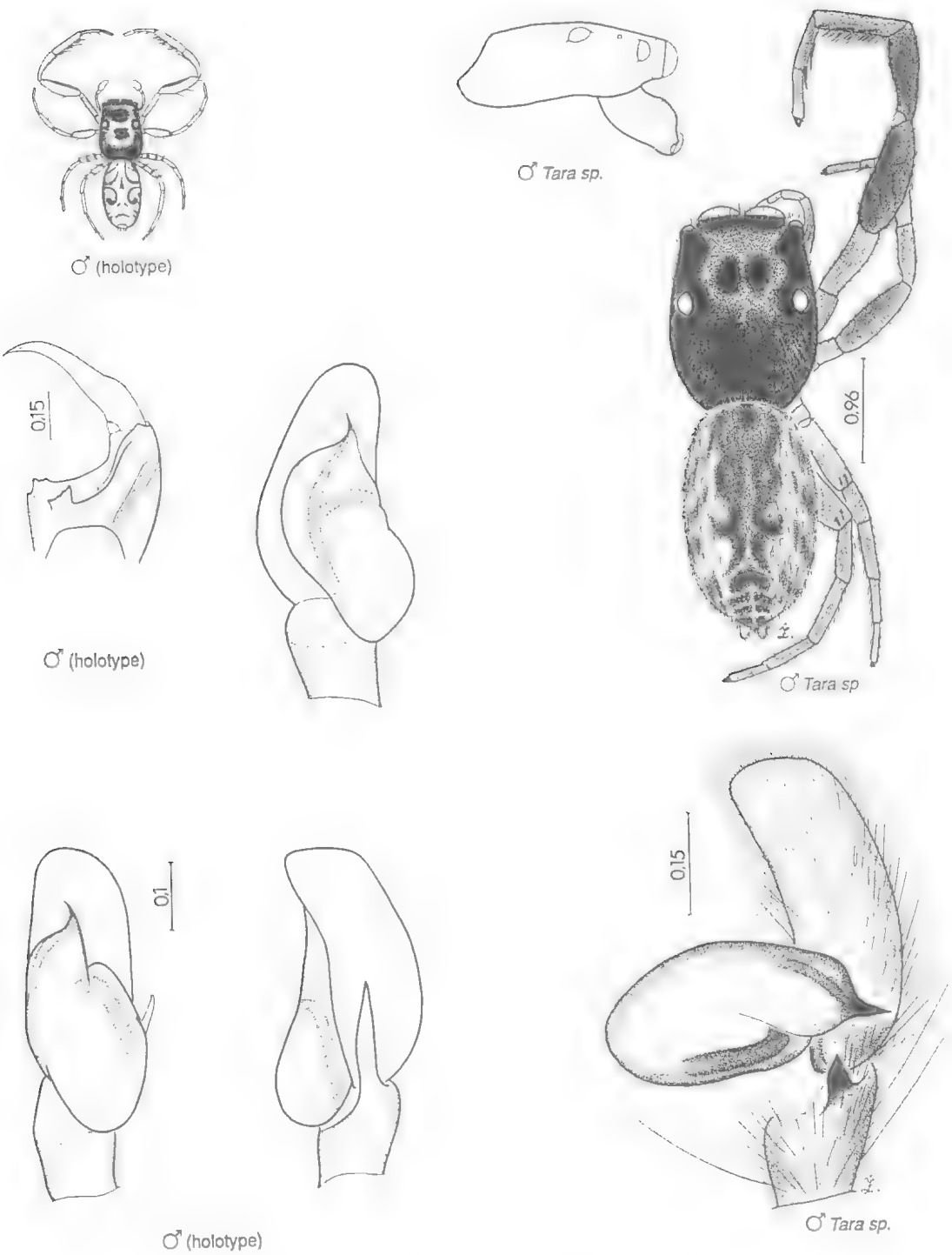
The dorsal view of *Tara anomala* is copied from the illustration in Koch and Keyserling (1871—1883). There are some undescribed ♂♂ of a small, flat spider, usually shaken from foliage, which have a similar ♂ palp to that of *Tara anomala* but do not have such elongate coxa and trochanter I. Until *T. anomala* is known these cannot be assigned with certainty to *Tara* and have not been figured.

Diolenius, a fly-mimic is found on the leaves of palms, ginger and other plants in north Queensland. The spider moves backwards, its elongate front legs resembling the wings of a fly.

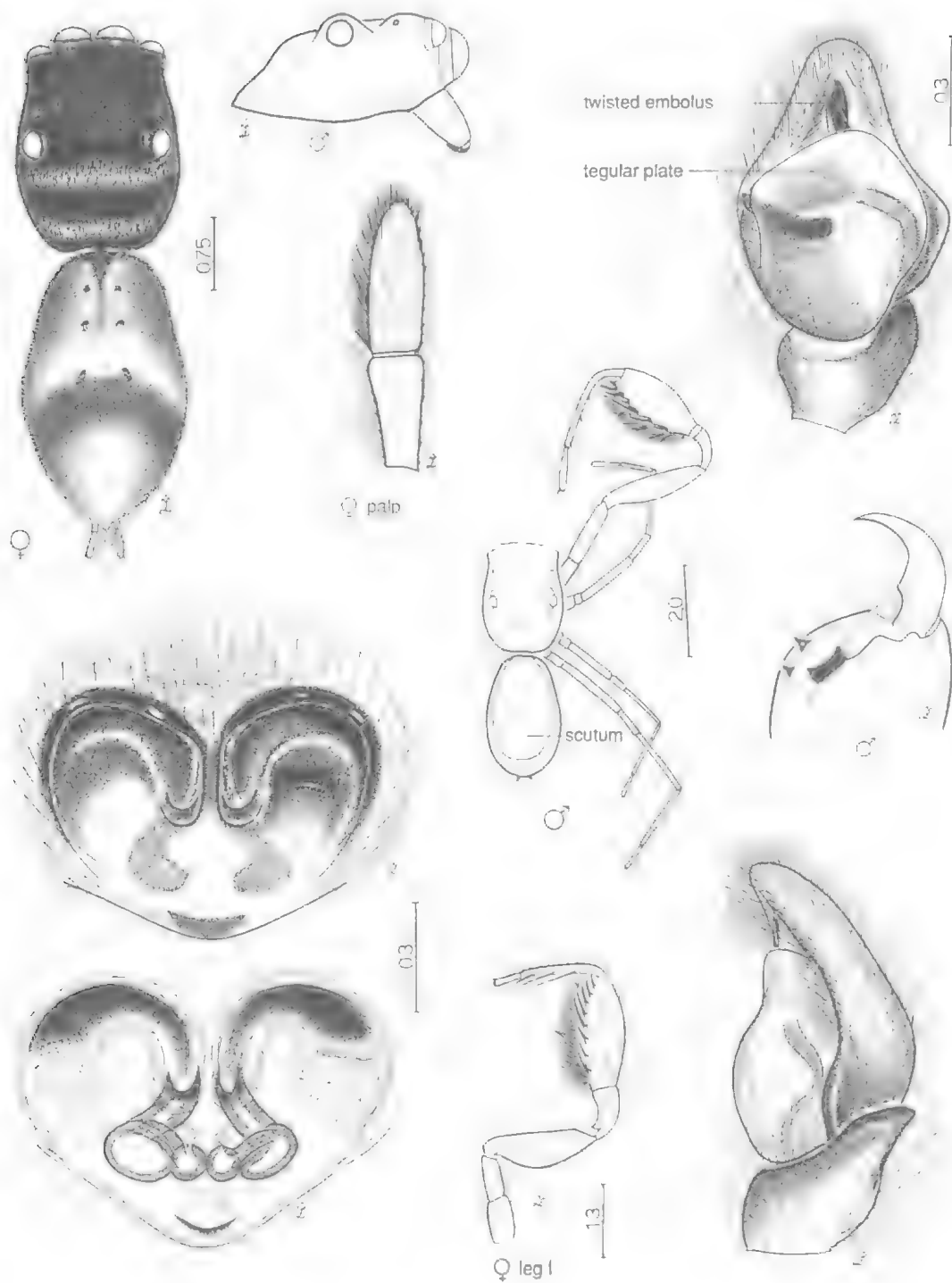
Harmochirus is recorded from Australia for the first time. It appears to be closely related to the unident genus *Bianor*. They have similar body shapes, ♂ palpal and ♀ epigynal structure. *Bianor* lacks swelling and heavy fringing on tibia I.

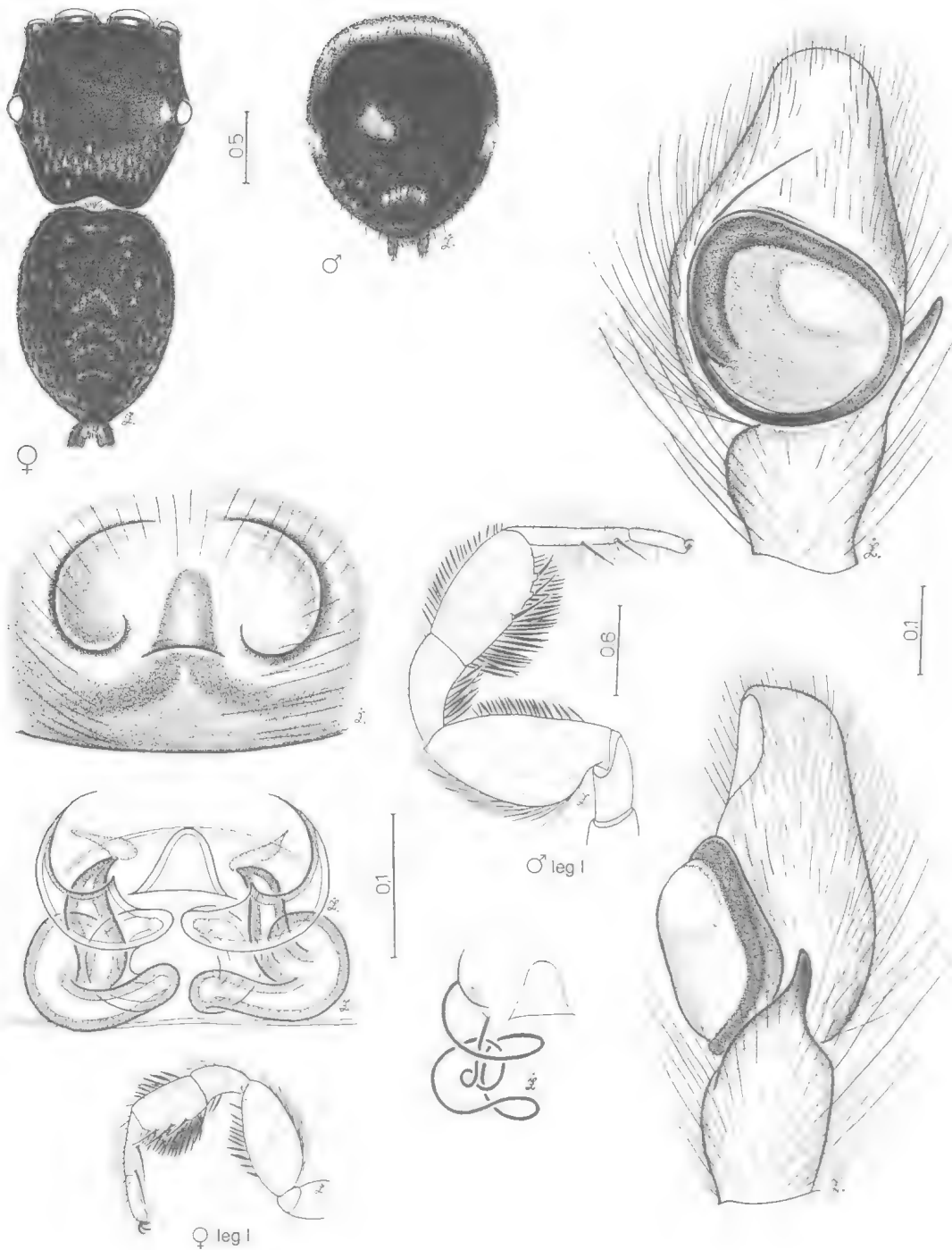
Opisthoncus is widespread in Australia with more than twenty described species. A few species have separate teeth (plurident) on the cheliceral retromargin rather than one divided tooth. The ♂ chelicera often has ventral and dorsal as well as marginal teeth.

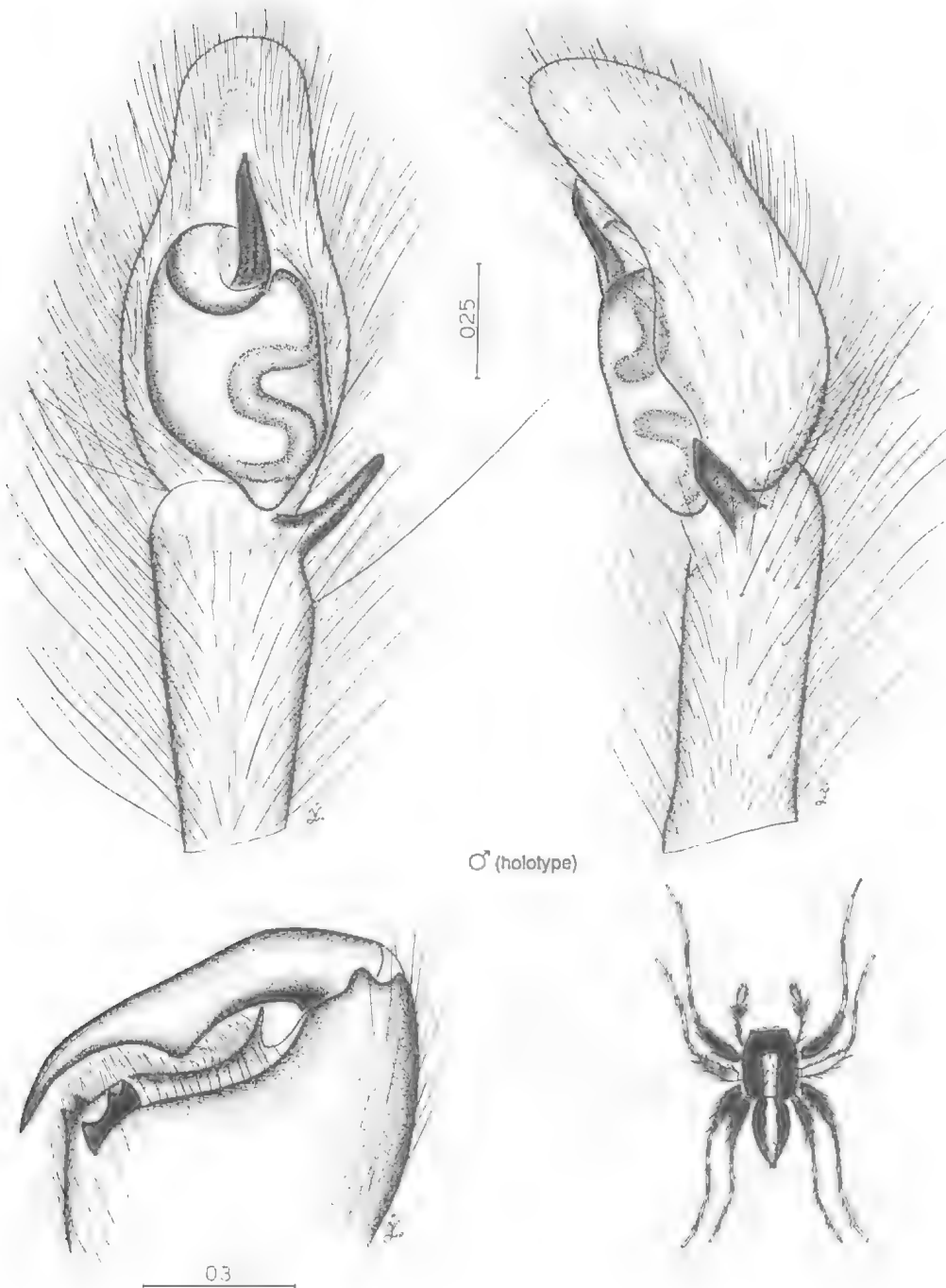
Ergane cognata is known only from the ♂ holotype from Pellew Is in the Gulf of Carpentaria, Northern Territory. The dorsal view is copied from the illustration in Koch and Keyserling (*loc. cit.*).



20. TARA ANOMALA (KEYSERLING, 1882) *

21. *DIOLENIUS* SP. loc. Cape York Peninsula, north Queensland

22. *HARMOCHIRUS BRACHIATUS* (THORELL, 1877) *



24. *ERGANE COGNATA* L. KOCH, 1881 *

7. PLE about middle of carapace. PME not much further from PLE than from ALE. ♂, ♀ sternum with conical prominence (Pl. 25) *Simaetha*
- PLE behind middle of carapace. PME much further from PLE than from ALE. Sternum without prominence (Pl. 26) *Simaethula*
8. Five pairs of ventral spines on ♀ tibia I (Pl. 27) *Adoxotoma*
(♂ unknown)
- Rarely more than 3 pairs of ventral spines on ♀ tibia I, never 5 pairs 9
9. Embolus short, uncoiled. Epigynum small and indistinct (Pl. 28) *Hasarius*
(introduced)
- Embolus coiled in anti-clockwise direction (in left palp). Epigynum clearly defined 10
10. ♂ chelicera long, porrect. ♀ epigynal fossa without clear median guide (Pl. 29) *Canama*
(northern Australia)
- ♂ chelicerae, geniculate. ♀ epigynum with paired fossae, clear median guide 11
11. Frontal surface of chelicera rounded. ♂ insemination ducts clearly evident through the integument, posterior to fossae. ♀ embolus 2-coiled; tegulum almost as wide as long (Pl. 30) *Cytaea*
- Frontal surface of chelicera rounded or flat. ♂ insemination ducts hardly if at all evident, level with fossae. ♂ embolus with single coil; tegulum clearly longer than wide 12
12. Frontal surface of chelicera rounded. ♂ chelicera bowed prolaterally with transverse ridges. ♀ tegulum with lobe posteriorly; embolus pointed. ♂ endite with retrolateral protuberance
..... (Pl. 31) *Servaea*
- Chelicerae flat-fronted, smooth. ♂ chelicerae straight edged without ridges. ♀ tegulum without lobe posteriorly; embolus bifurcate at tip. ♂ endite without retrolateral protuberance
..... (Pl. 32) *Euryattus*

Simaetha spp. are medium-sized spiders that are commonly found in small webs under the bark of eucalypts. Jackson (1985c) discusses their web-building, predatory and intraspecific behaviours.

Simaethula is a small spider closely related to *Simaetha*.

Hasarius adansonii, an introduced spider, is often the first spider to colonise new buildings in Brisbane.

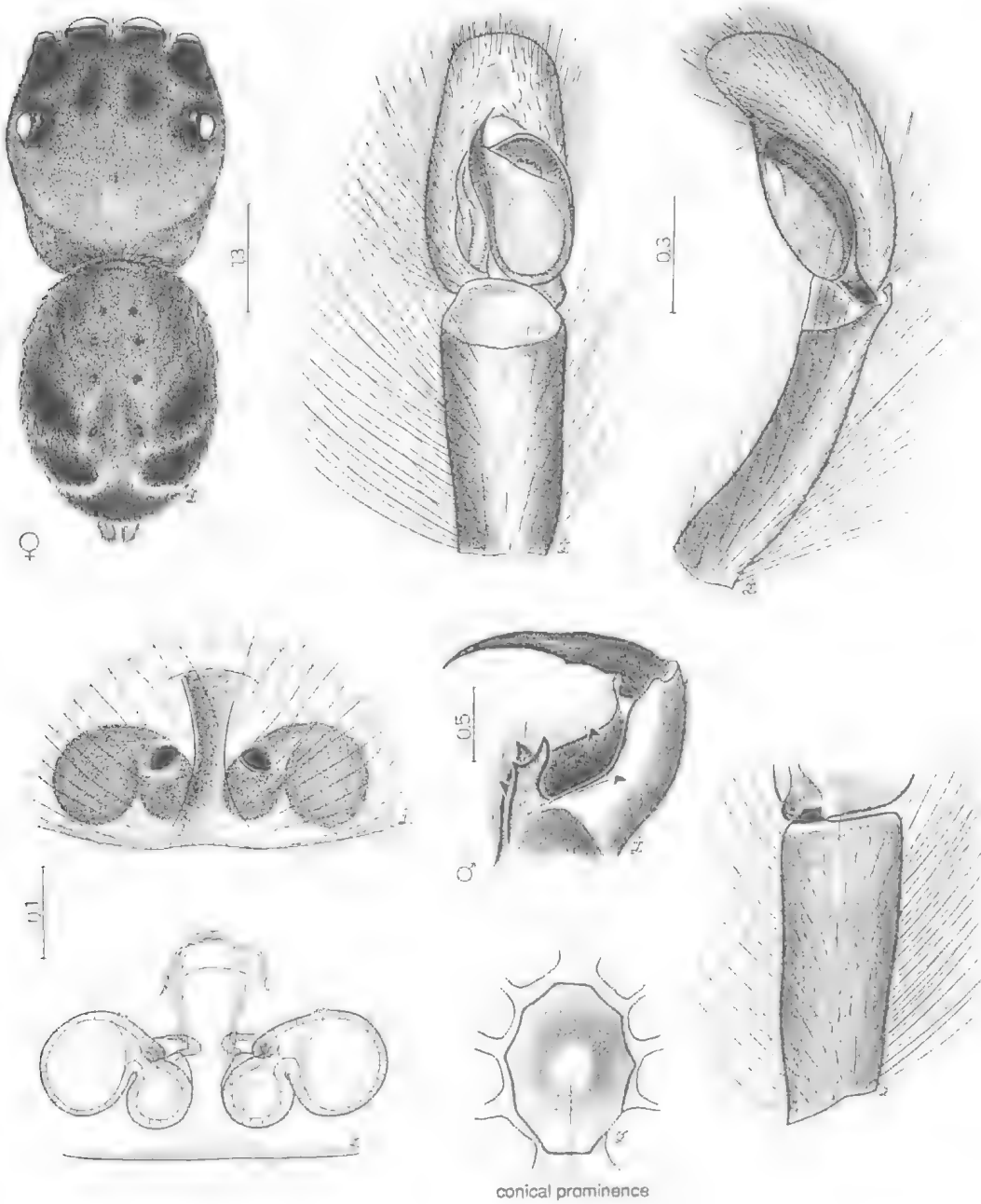
Adoxotoma, usually regarded as a plurident spider because the carapace resembles that of the Astieae, is placed here because of its fissident retromarginal dentition. The ♂ is unusual having strong spination (without swelling) on tibia I. The ♀ is not known. Apart from the drawings of the epigynum and leg I, the illustrations are copied from Wanless (1988) who, in his revision of the Astieae, did not assign *Adoxotoma* to a sub-family.

The ♂ *Canama hinnuleus* is illustrated for the first time. Prószyński (1984) transferred *C. hinnuleus* to *Bathippus* and later (1987 *in index*) synonymised *C. forceps*, the type species with *Bathippus cervus*. We believe that *Canama* is a valid genus that differs in cheliceral and epigynal structure from *Bathippus* (see *B. sedatus* and *B. shelfordi* in Zabka, 1988).

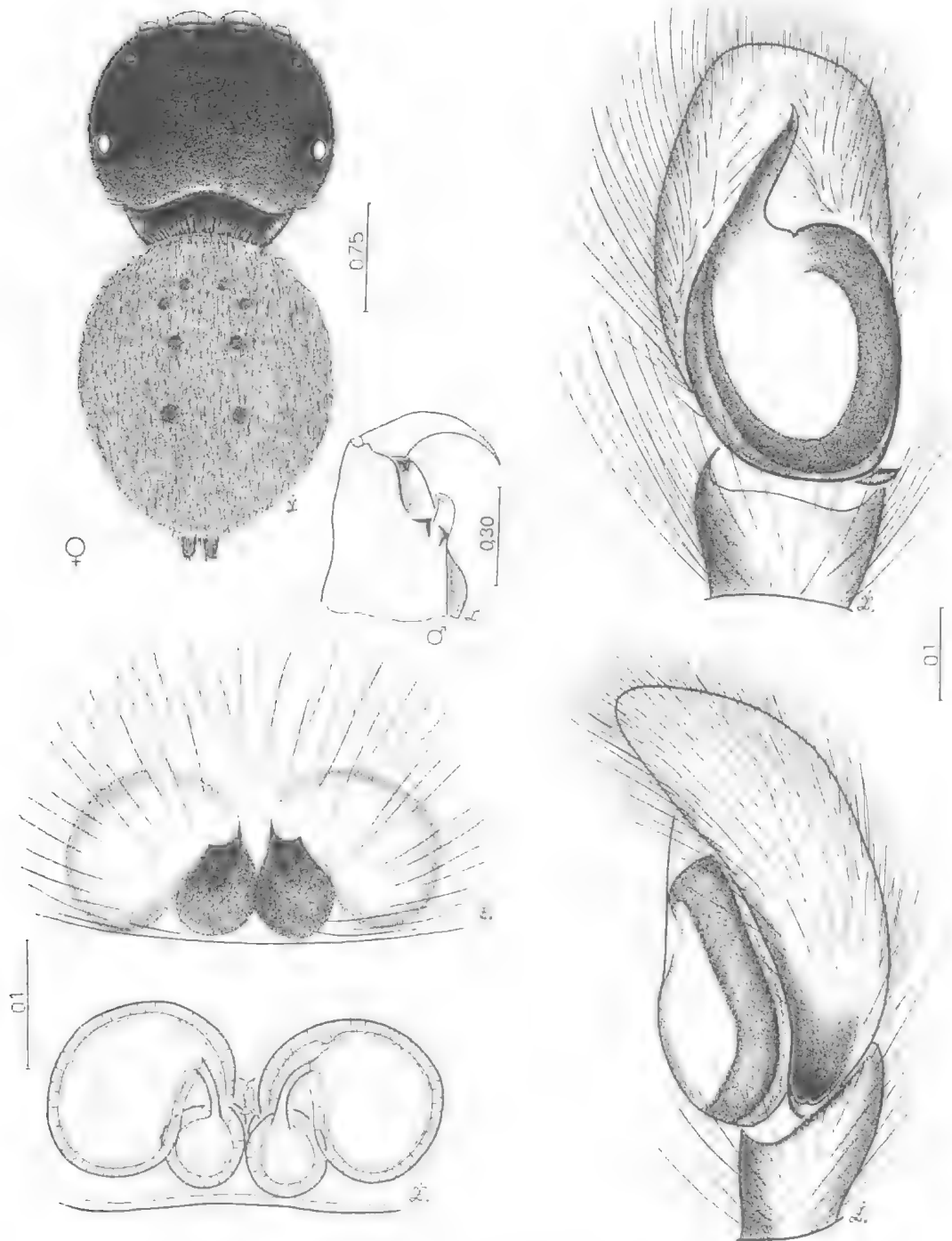
Cytaea spp. are found in grassland and on the leaves of shrubs and trees. The abdominal hairs are often rubbed off in preserved specimens which thus show less pattern.

Simon (1887: CLXXXVI) provided the replacement name *Servaea* for *Scuea* L. Koch, 1879 *praeocc.* *Servaea vestita* is found under the loose bark of eucalypts. The spider (as *Plexippus validus*) in Mascord (1970, Pl. 11, fig. 42) is probably *Servaea*.

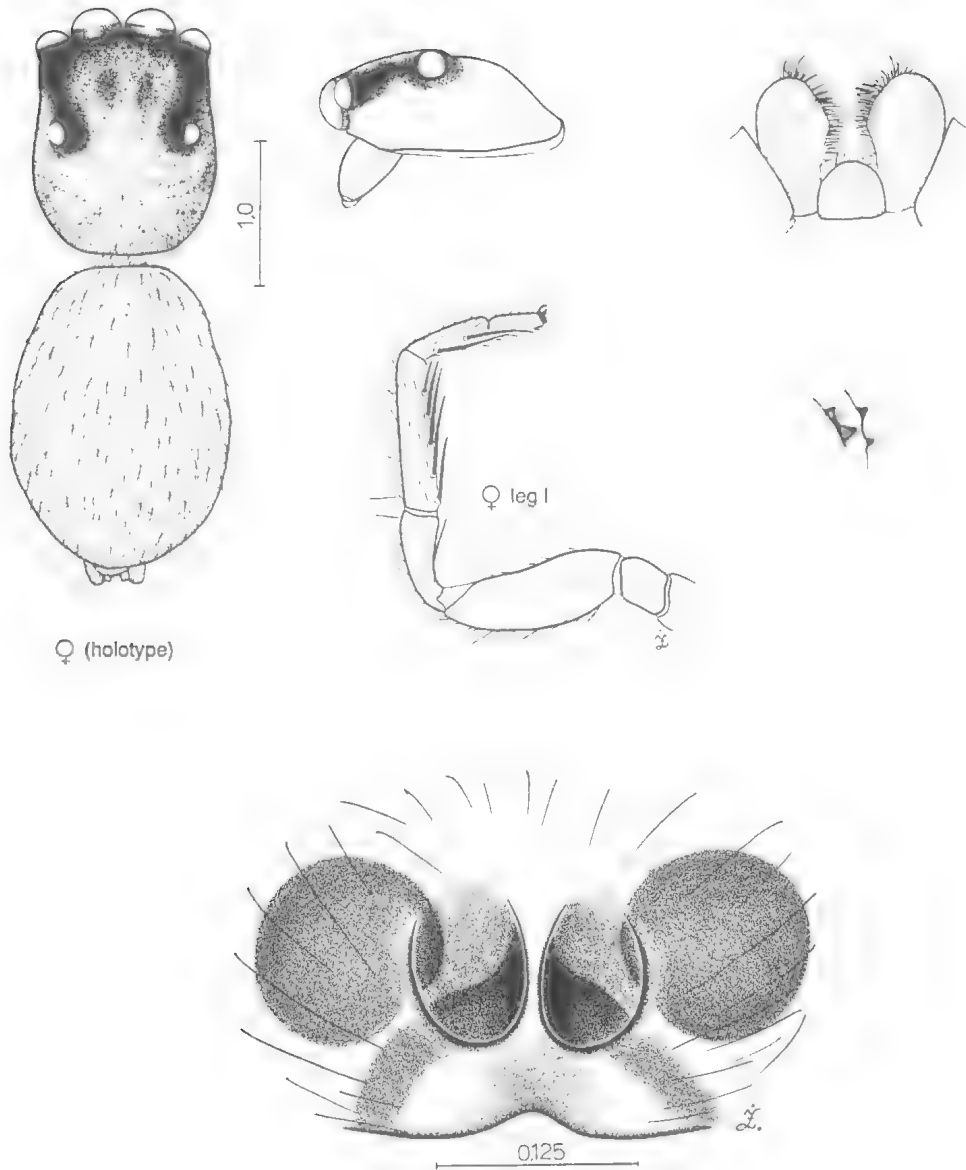
There are several undescribed *Euryattus* spp. in Australia. Jackson (1985b) discusses the biology of one from northern Queensland rainforest and its practice of using a suspended curled leaf as its nest.



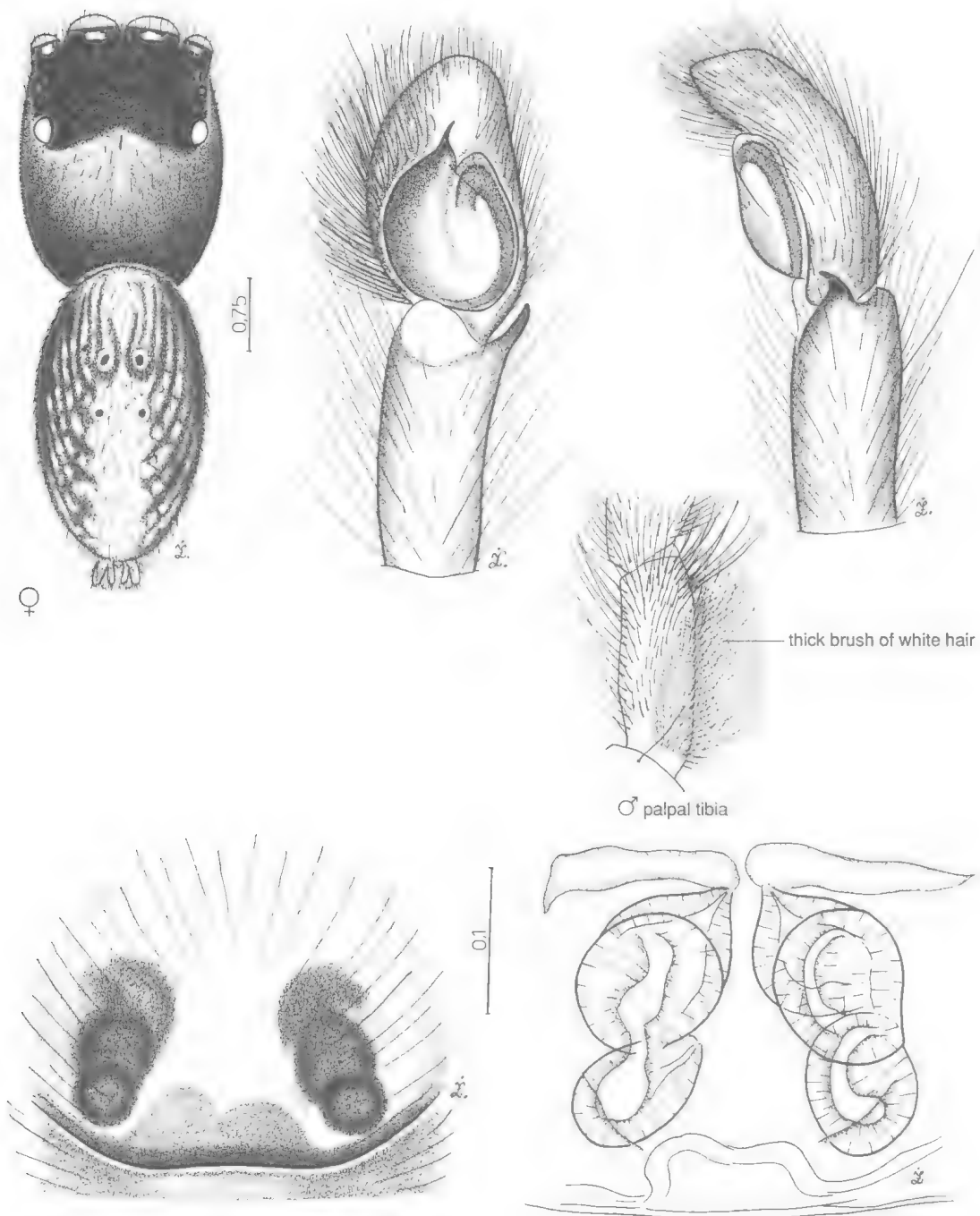
25. SIMAETHA THORACICA THORELL, 1881 *



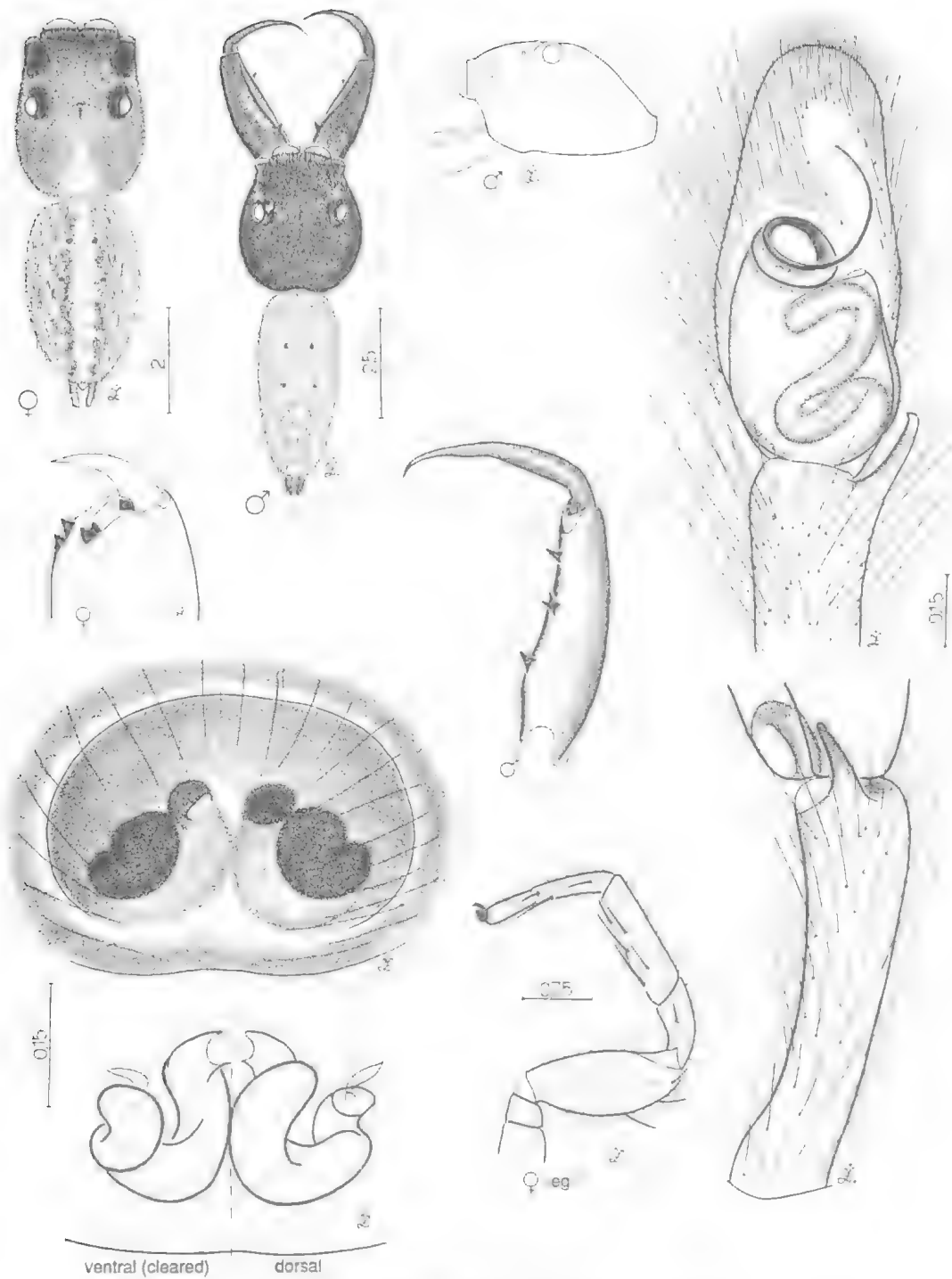
26. *SIMAETHULA* SPP. loc. ♀ Cape Tribulation, north Queensland,
♂ Brisbane, southeast Queensland



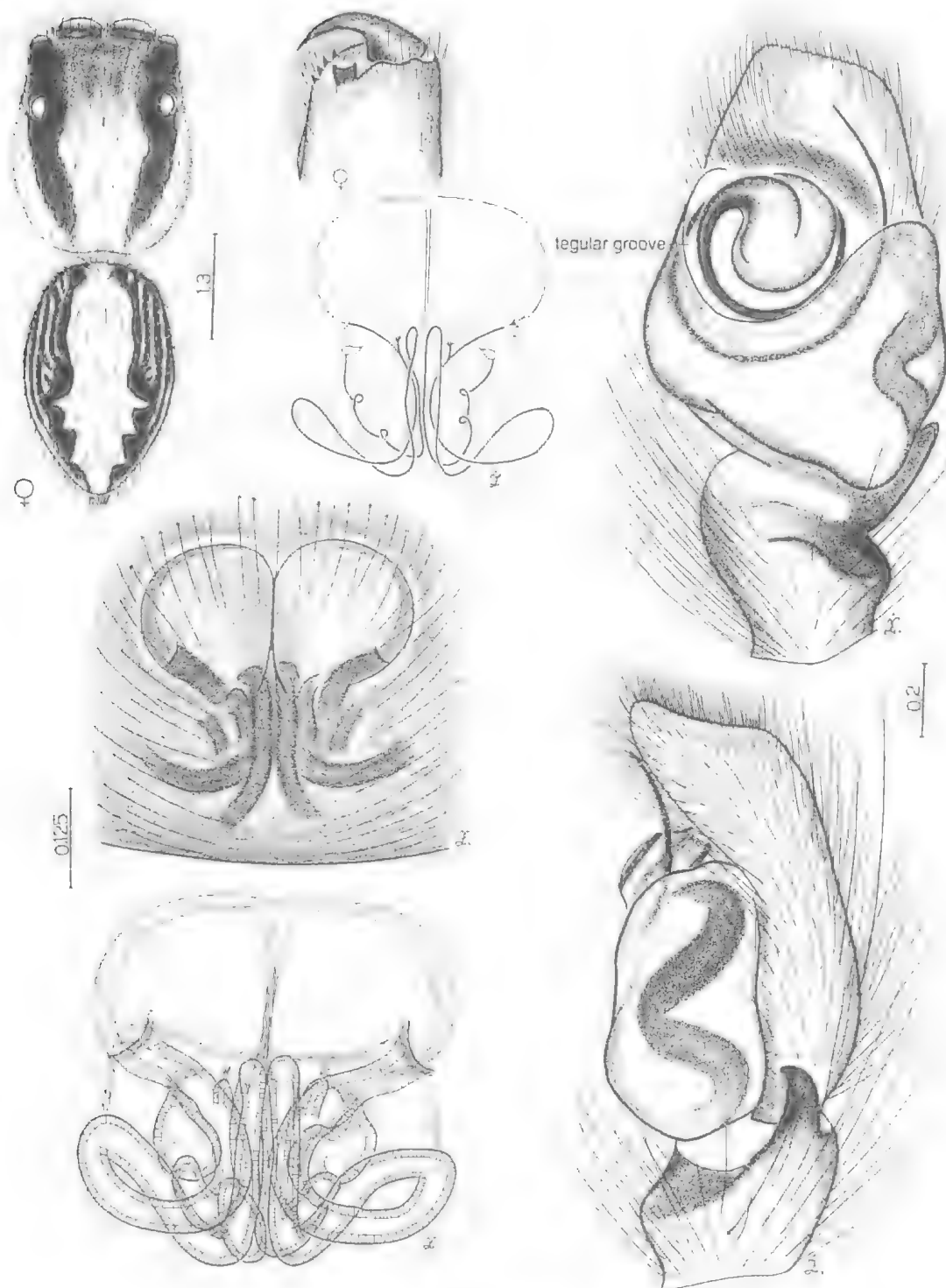
27. *ADOXOTOMA NIGROOLIVACEA* SIMON, 1909 *



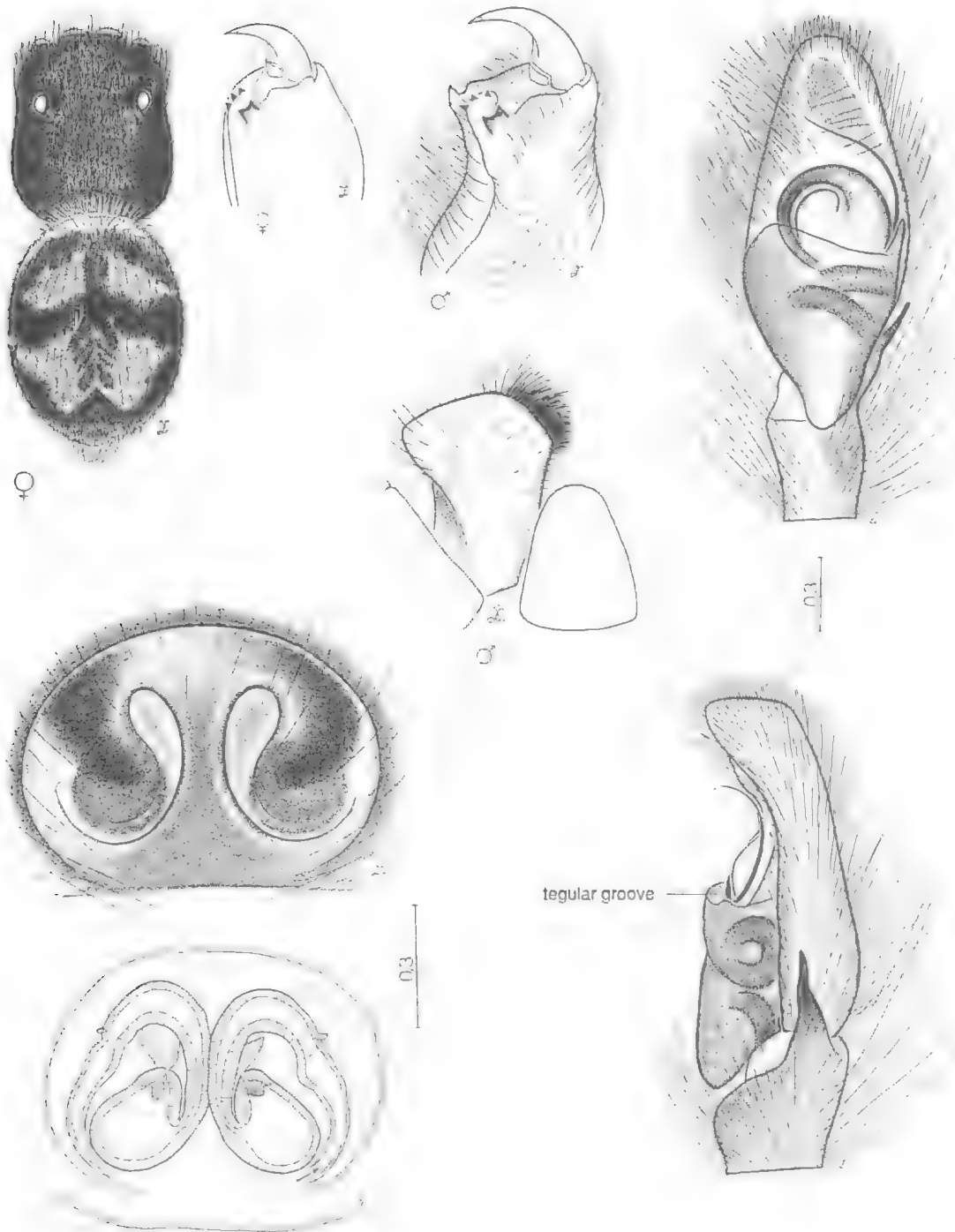
28. HASARIUS ADANSONI (SAVIGNY & AUDOUIN, 1825) *

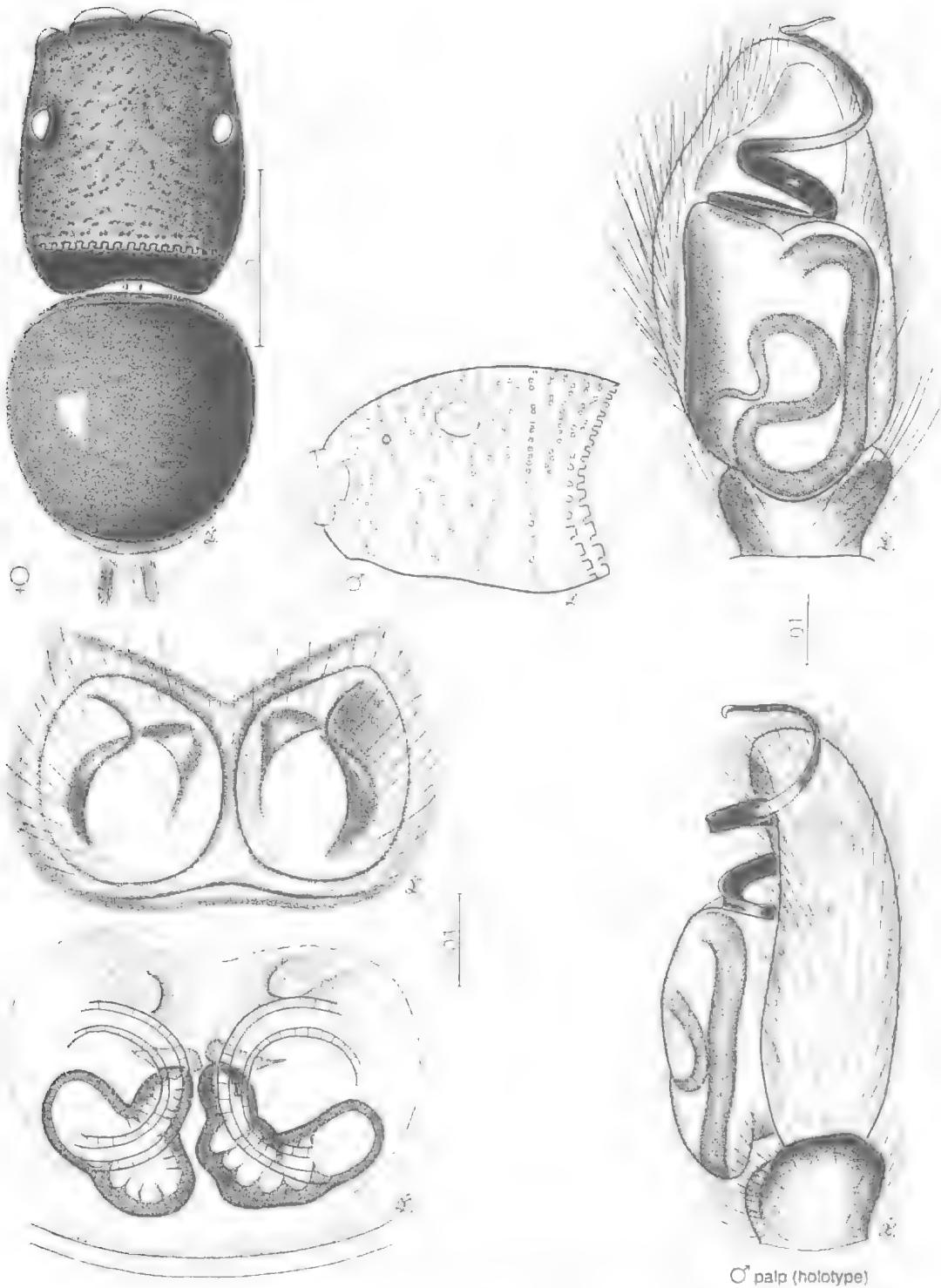


29. CANAMA HINNULEUS (THORELL, 1881)



30. CYTAEA ALBURNA KEYSERLING, 1882 *

31. *SERVAEA VESTITA* (L. KOCH, 1879) *



33. COCCORCHESTES FERREUS GRISWOLD, 1984

UNIDENTATI — KEY TO GENERA

1. Carapace shiny and cylinder-like with crenellated posterior margin overlying abdomen. ♀ and ♂ with shiny dorsal abdominal scutum (Pl. 33) *Coccorchestes* (northern Australia)
- Carapace not cylinder-like and without crenellated margin, ♀ without abdominal scutum 2
2. Cephalothorax high with almost vertical declivity posteriorly. Abdomen heart-shaped (Pl. 34) *Omoedus* (northern Australia)
- Cephalothorax otherwise. Abdomen rarely heart-shaped 3
3. ♂ palp with strongly curved (anti-clockwise in left palp) anterior conductor/embolus. ♀ with adjoining epigynal fossae; spermathecae level with or posterior to fossae 4
- Without this combination of ♂ and ♀ characters. ♂ conductor/embolus usually runs clockwise, if anti-clockwise not strongly curved 13
4. Carapace strongly rounded in front; swelling below lateral eyes. Small tooth on retromargin of cheliceral groove. ♂ palp with tightly coiled conductor/embolus; tegulum without lobe posteriorly (Pls 35,36,37) *Zenodorus* (includes *Mollika* and Australian *Pystira* spp.)
- Carapace rarely strongly rounded in front; without swelling below lateral eyes. Strong conical tooth on retromargin of cheliceral groove. ♂ palp with loosely coiled or curved conductor/embolus; tegulum with lobe posteriorly 5
5. Leg III as long as or longer than leg IV. Without brushes on ♂ leg I 6
- Leg III shorter than leg IV. With brushes on ♂ leg I (exc. '*Salpesia*' *squalida*) 10
6. Ocular quadrangle clearly narrower behind than in front 7
- Ocular quadrangle equal or slightly narrower behind 8
7. Carapace clearly wider than PLE and widening further in *pars thoracica*. Patch of strong bristles between ALE. Abdomen almost as wide as long. ♀ spermathecae close together (Pl. 38) *Margaromma* (♂ unknown)
- Carapace slightly wider than PLE and scarcely widening in *pars thoracica*. Without patch of strong bristles between ALE. Abdomen much longer than wide. ♀ spermathecae well separated. ♂ palpal tibia with long, stout seta dorsally (Pl. 39) *Palpelius*

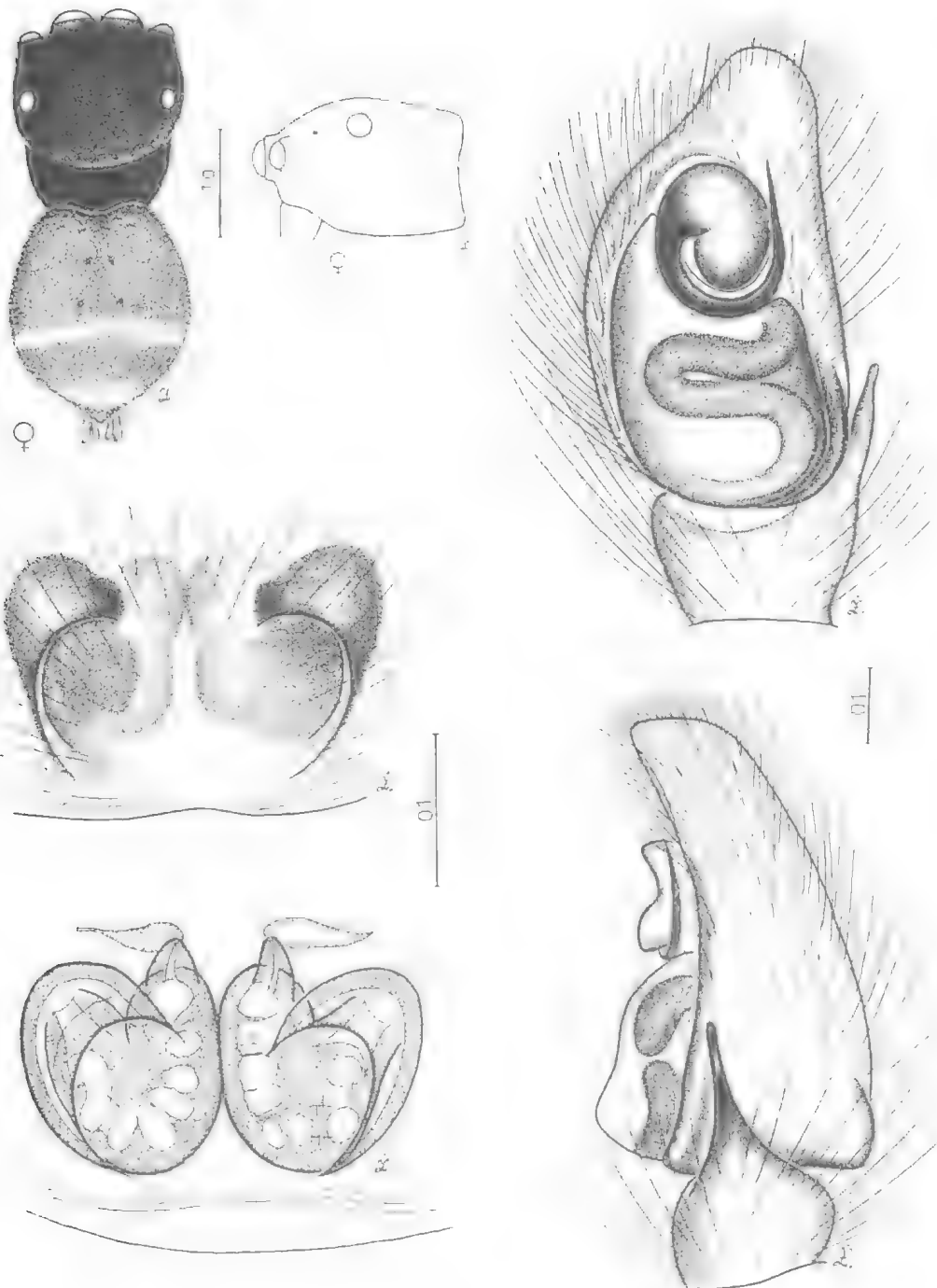
Griswold (1984) described the ♀ *Coccorchestes ferreus* from north Queensland. The ♂ *C. ferreus* is illustrated for the first time; its 'chambered' spermathecae are similar to those found in *Omoedus*.

Omoedus is recorded from Australia for the first time. Like *Coccorchestes*, it is a small spider, better known from Papua New Guinea.

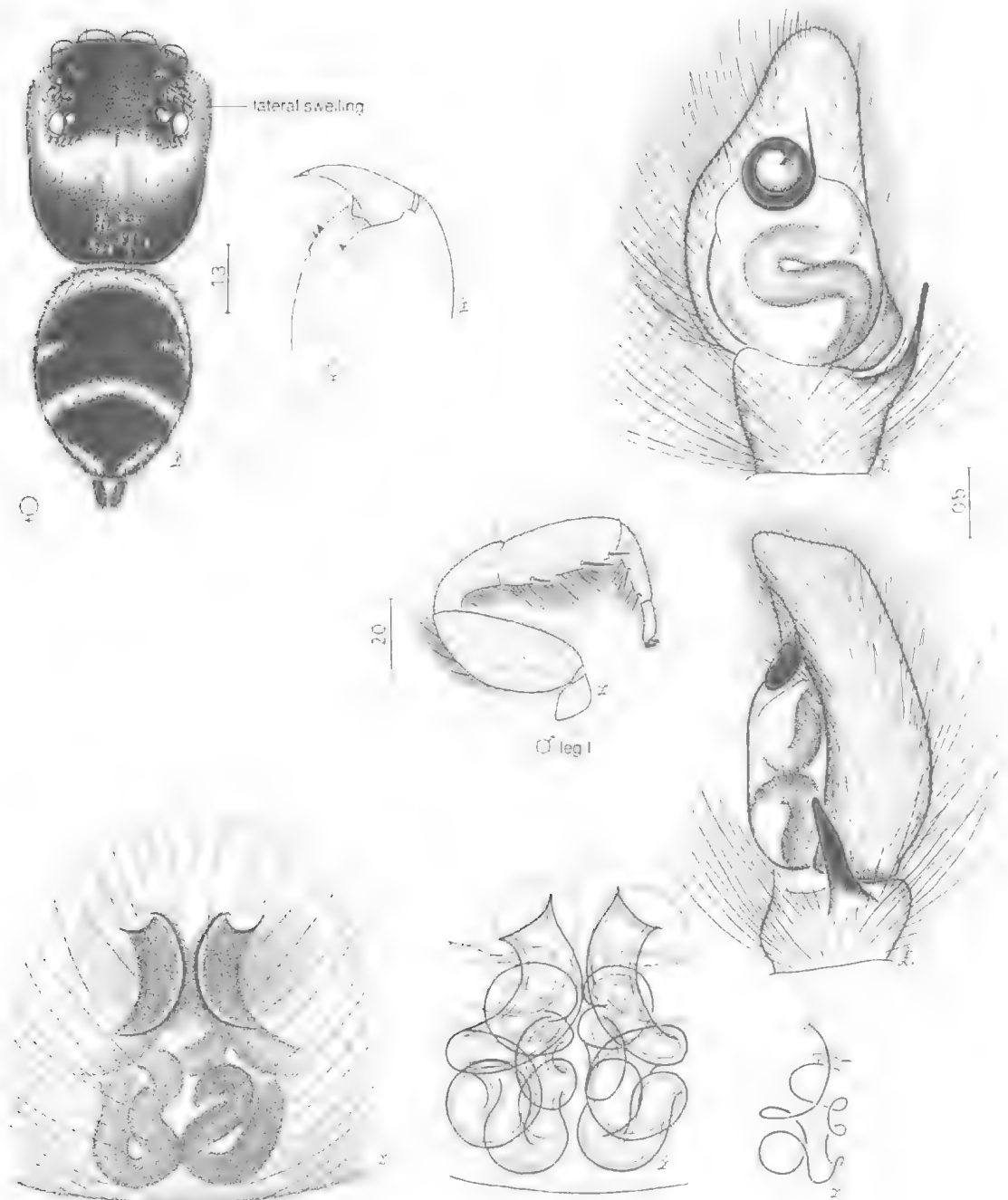
Zenodorus, *Mollika* and *Pystira* were among the genera in Simon's group, Zenodoreae. Žabka (1988) has recently placed *Mollika* Peckham & Peckham, 1901 as a junior synonym of *Zenodorus* Peckham & Peckham, 1885. We have transferred the Australian *Pystira* spp. to *Zenodorus* thus *Pystira orbiculata* = *Zenodorus orbiculatus* (Keys., 1881) n.comb., and *Pystira obscurifemorata* = *Zenodorus obscurifemoratus* (Keys., 1881) n.comb. In *Z. durvillei* leg III of the ♂ is longer than leg IV and it lacks the white scale-like hairs found on the front of the ♂ chelicerae in the other species.

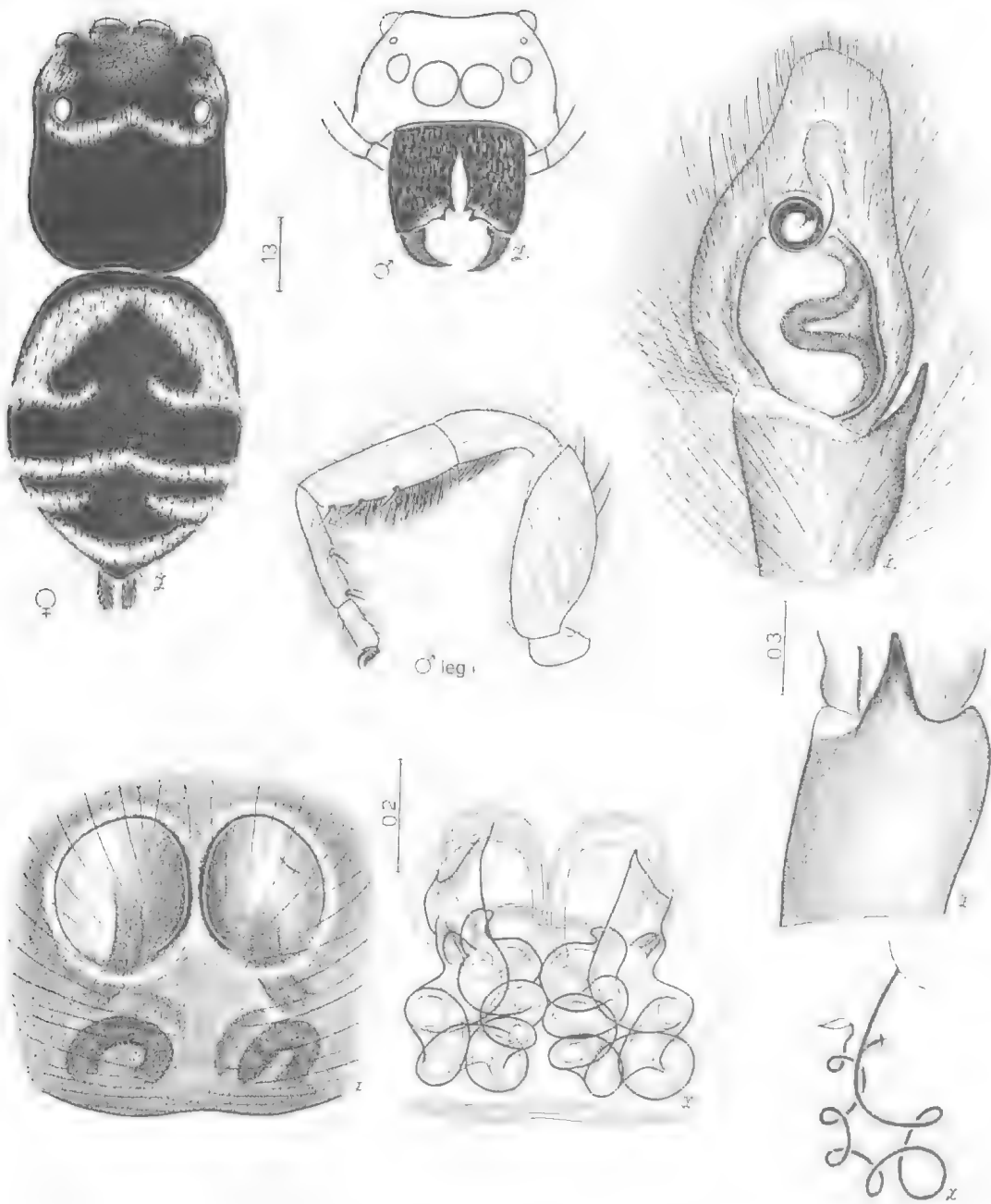
When describing *Margaromma*, Keyserling (Koch and Keyserling 1871–1883) had 3 specimens, a ♀ from Cape York (in BMNH) and ♀ and ♂ — 'Parchen' (loving couple) — from Sydney which we have not located. The ♀ syntype from Cape York is without doubt that illustrated (Koch and Keyserling *loc. cit.*) and it is re-figured here. Spiders similar to the ♂ syntype have been found in Sydney and will be described later, with the ♀♀, as a new genus.

Simon (1897–1903: 735) chose *Plexippus beccarii* Thorell, 1881 as the type species of the genus *Palpelius*. It is a large spider found in northern Australia. It is unlikely that it is closely related to the following 'saitine' group of genera.

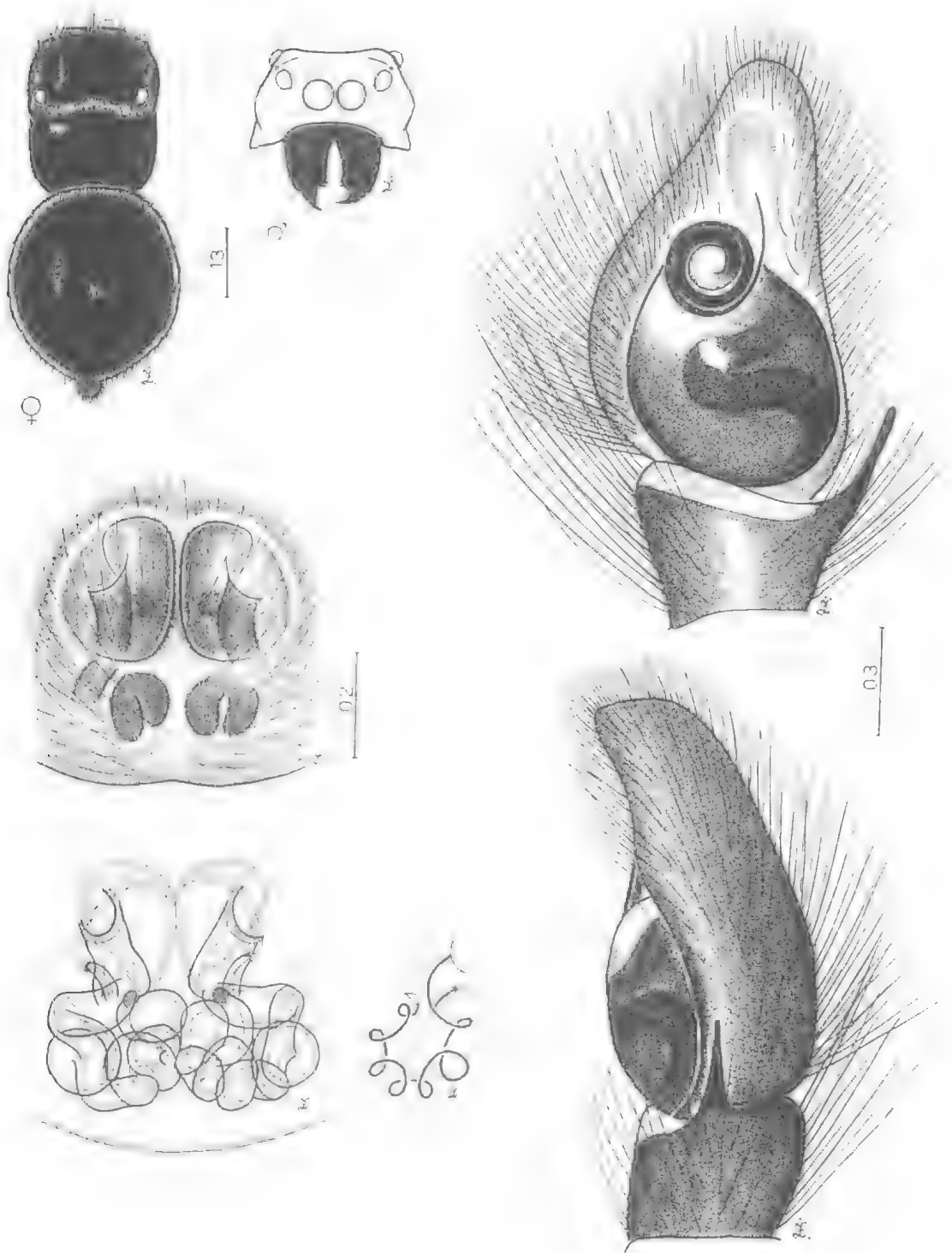


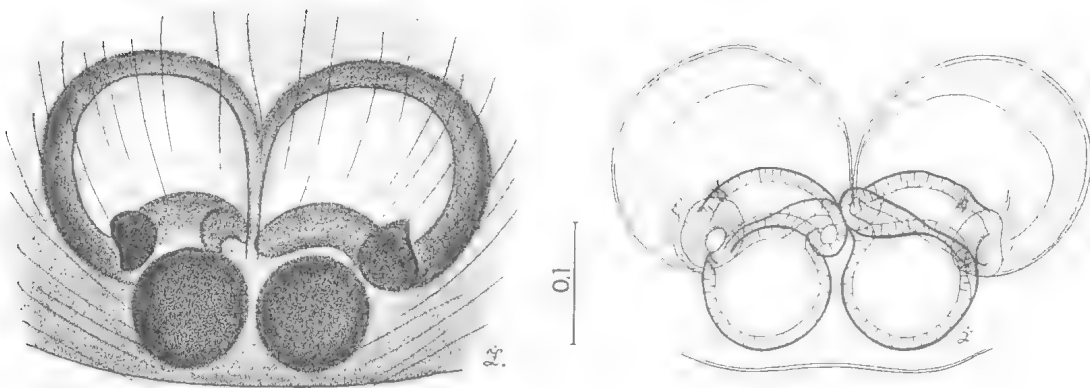
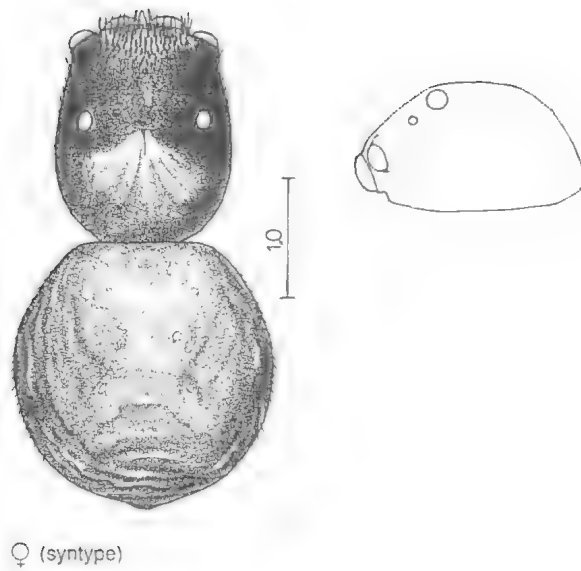
34. OMOEDUS SP. loc. Iron Range, north Queensland

35. *ZENODORUS DURVILLEI* (WALCKENAER, 1837) *

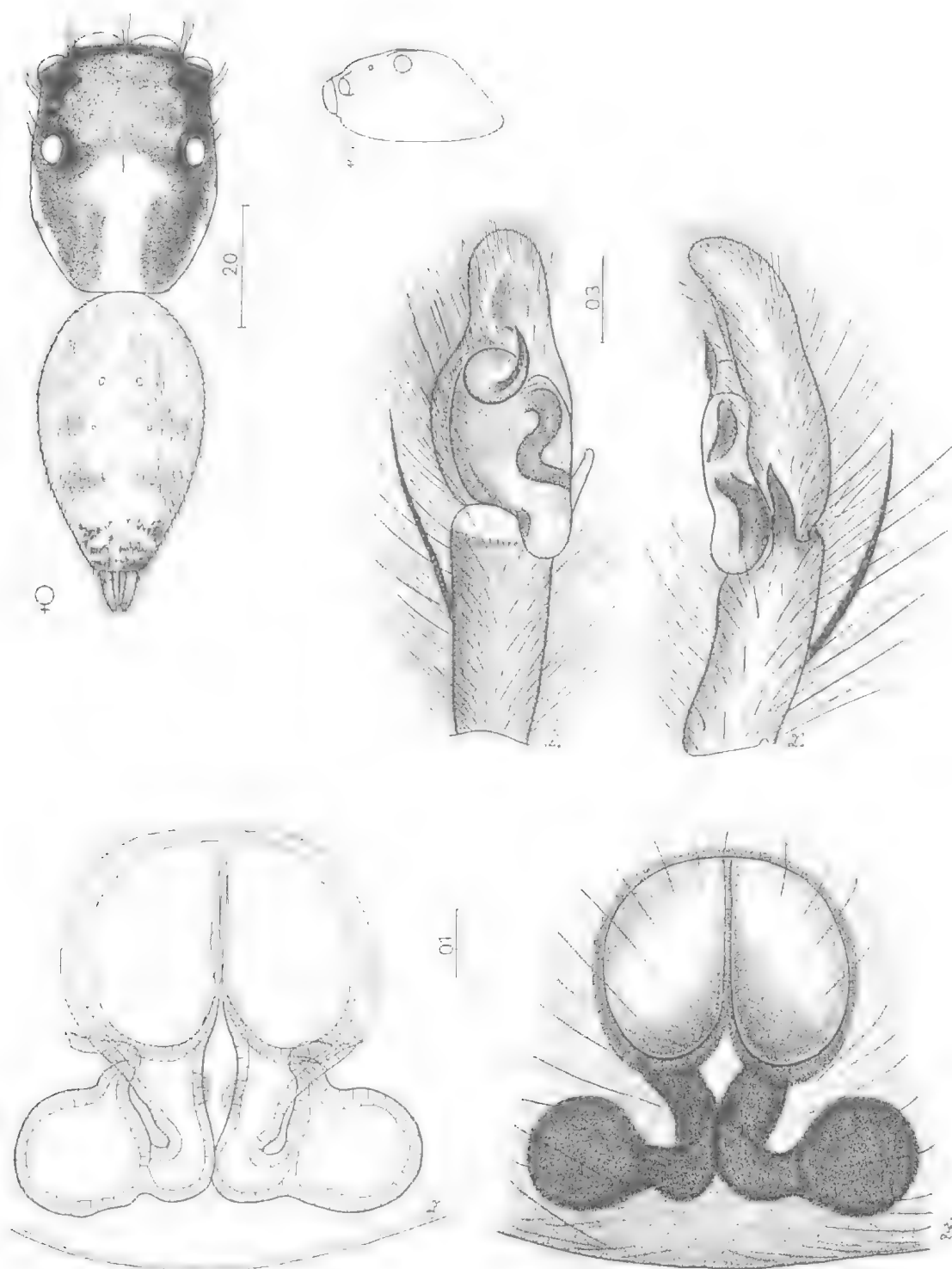


36. ZENODORUS METALLESCENS (L KOCH, 1879)

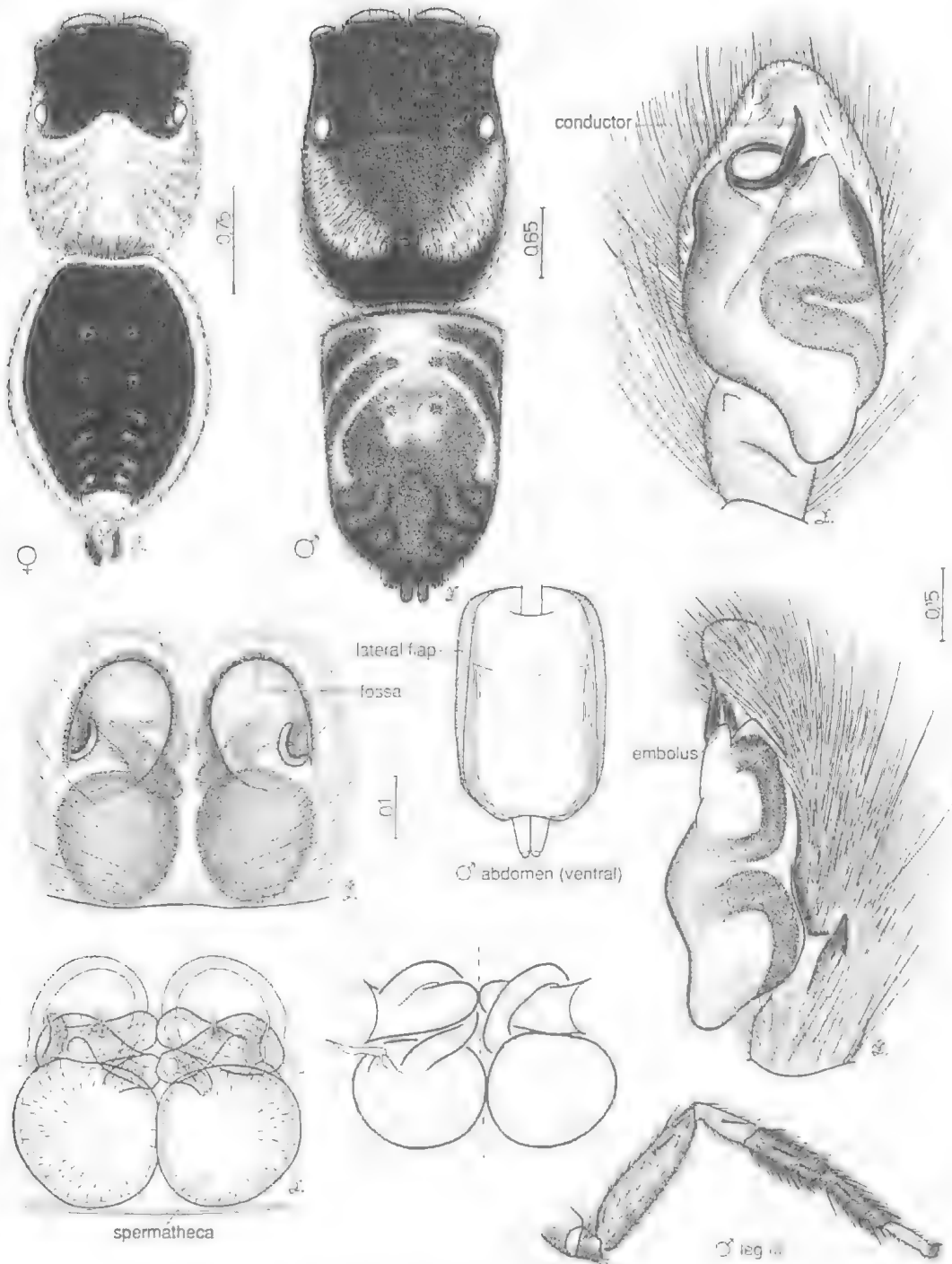
37. *ZENODORUS ORBICULATUS* (KEYSERLING, 1881) N. COMB.



38. MARGAROMMA FUNESTUM KEYSERLING, 1882 *



39. PALPELIUS BECCARII (THORELL, 1881) *



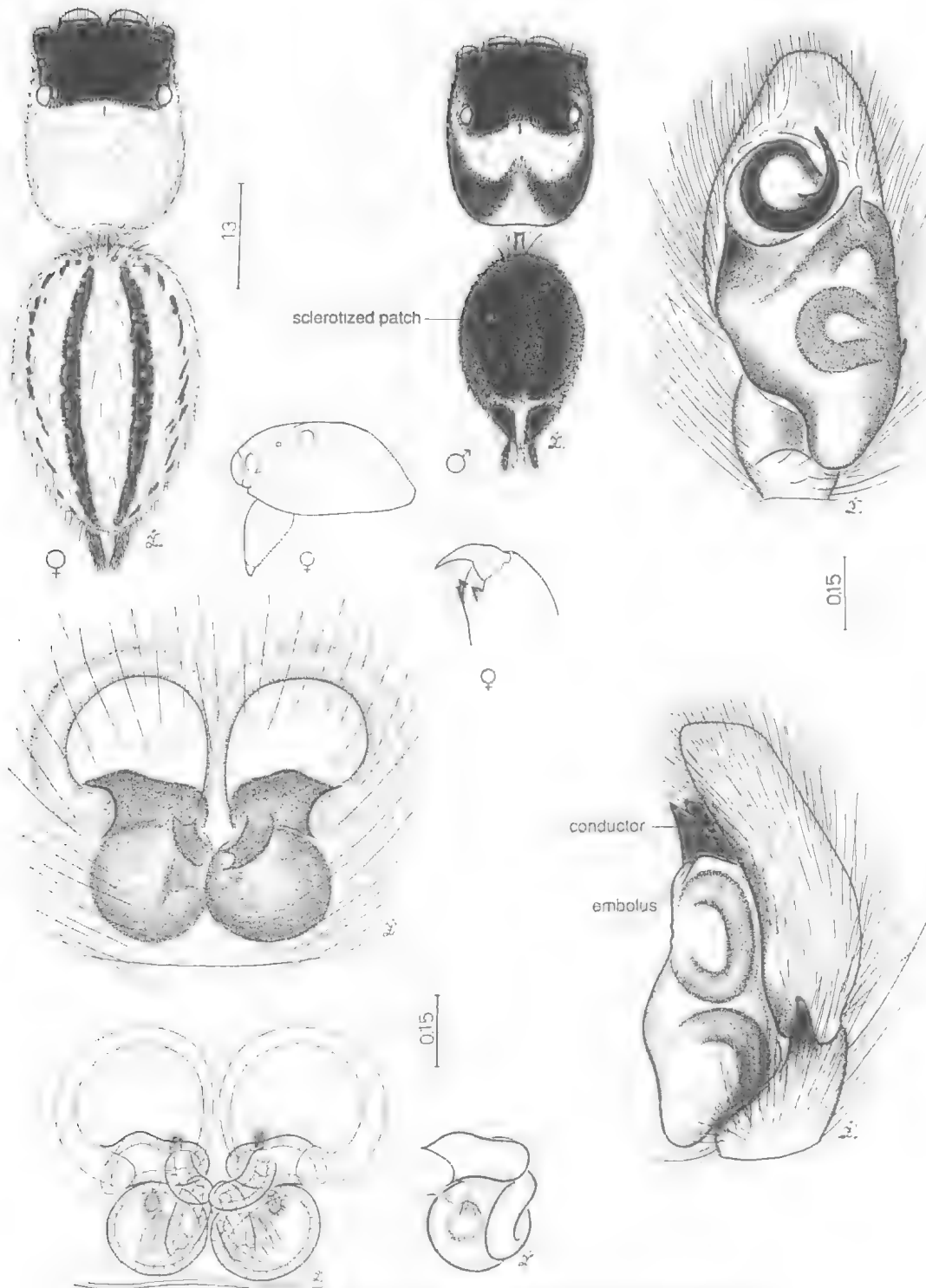
40. MARATUS SP. loc. Brisbane, southeast Queensland

8. Iridescent scale hairs on ♂ abdomen. Brushes of hair on ♂ tibia and metatarsus III. Chelicera with 2 promarginal teeth. ♀ spermathecae wider than fossae (Pl. 40) *Maratus*
- Without iridescent hairs on ♂ abdomen. With or without brushes of hair on ♂ tibia III. Chelicera with one fissident promarginal tooth. ♀ spermathecae not as wide as fossae 9
9. With or without slight brushes of hair on ♂ tibia III. Without mat of short thick hair between eyes of ♂. Chelicera with pointed retromarginal tooth. Dorsal abdominal sclerotization in ♂ (Pl. 41) *Lycidas*
- Brushes of hair on ♂ femur, patella, tibia III. Mat of short, thick hair between eyes of ♂. Chelicera with large, blunt retromarginal tooth. Without dorsal abdominal sclerotization in ♂ (Pl. 42) *Hypoblemum*
10. Ocular quadrangle clearly narrower behind. ♂ without brushes of hair on leg I. ♀ insemination ducts arising medially; spermathecae level with fossae (Pl. 43) '*Salpesia*' *squalida*
- Ocular quadrangle equal or slightly narrower behind. ♂ with brushes of hair on leg I. ♀ insemination ducts arising laterally, spermathecae partly posterior to fossae 11
11. Carapace bordered laterally by pale band (often with white hairs). Fringes on femur, patella, tibia, metatarsus and tarsus ♂ leg I. ♂ embolus and conductor separate. ♀ spermathecae spherical ... 12
- Carapace not bordered laterally by pale band. Fringe on ♂ metatarsus I only. Single conductor/embolus. ♀ spermathecae pear-shaped (Pl. 44) *Prostheclina*
12. ♂ with stridulatory ridges at back of carapace (Pl. 45) '*Lycidas*' *michaelseni*
- ♂ without stridulatory ridges at back of carapace (Pl. 46) *Jotus*
(♀ unknown)

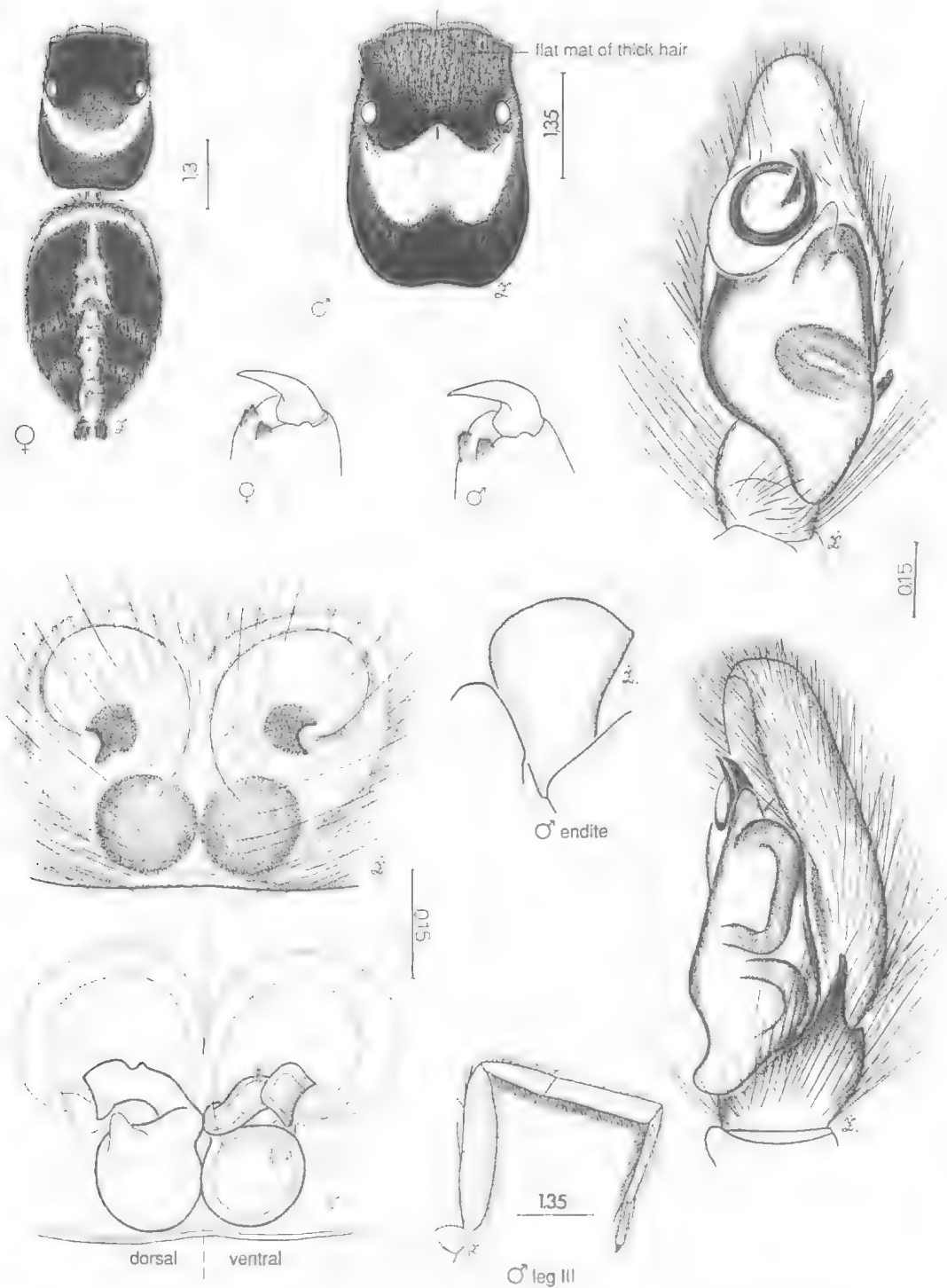
In the 3 spiders, *Maratus*, *Lycidas* and *Hypoblemum*, leg III of the ♂ is longer than leg IV and usually shows some fringing. Žabka (1987b) has reinstated *Maratus* Karsch; the ♂ has iridescent abdominal scale hairs that give various multi-coloured patterns which are specific. Mascord (1970, Pl. 10, fig. 35) shows ♂ *M. volans* (as *Saitis*). The dorsal abdomen of the ♂ is produced laterally to form flaps of varying size which are raised when the abdomen is erect during courtship (pers. comm. Julianne Walldock). The ♀, illustrated here for the first time, is sombrely coloured. Žabka (*loc. cit.*) also reinstated *Lycidas* Karsch. *Acmaea villosus* Keys., the type species of *Hypoblemum*, has not been traced. However the genus is recognised by the ♂, which has a dense mat of flat hair between the eyes, heavy fringing on leg III, and lacks iridescent abdominal hairs. The ♀ is illustrated for the first time.

In '*Salpesia*' *squalida*, *Prostheclina*, '*Lycidas*' *michaelseni* and *Jotus* leg IV is longer than leg III and, in all except '*S.*' *squalida*, there is fringing on ♂ leg I. The syntypes of '*Salpesia*' *squalida* have not been located, the ♀ is drawn from fresh material, and the ♂ palp is copied from Koch and Keyserling (*loc. cit.*). The ♀ epigyne is quite different from that of *Salpesia soricina* from the Seychelles. We believe that Keyserling's ♂ syntype of *Prostheclina pallida*, which has not been located, was not conspecific with the syntype ♀ (BMNH). Simon (1897-1903: 565) placed *Prostheclina* as a junior synonym of *Saitis*; we reinstate it as a valid genus because the pear-shaped spermathecae, the embolic structure, the shortness of ♂ leg III and the fringing of ♂ metatarsus I are quite unlike those of *Saitis*. We include in the genus only *P. pallida*; there are several undescribed species. Other than the ♂ holotype, only one ♂ *Jotus auripes* has been found and it is illustrated; the ♀ remains unknown but it is expected to have swollen insemination ducts similar to those of '*Lycidas*' *michaelseni*. *Jotus* was synonymised with *Lycidas* by Žabka (1987b). It is reinstated and may be separated from *Lycidas* by ♂ leg III being shorter than IV and the presence of fringes on ♂ leg I. ♂ '*Lycidas*' *michaelseni* from Western Australia differs from *Jotus* in the possession of stridulating ridges at the back of the carapace. See Gwynne and Dadour (1985) for details of the part stridulation plays in courtship. This is the first illustration of the ♂ palp; congeneric spiders have been found in Queensland.

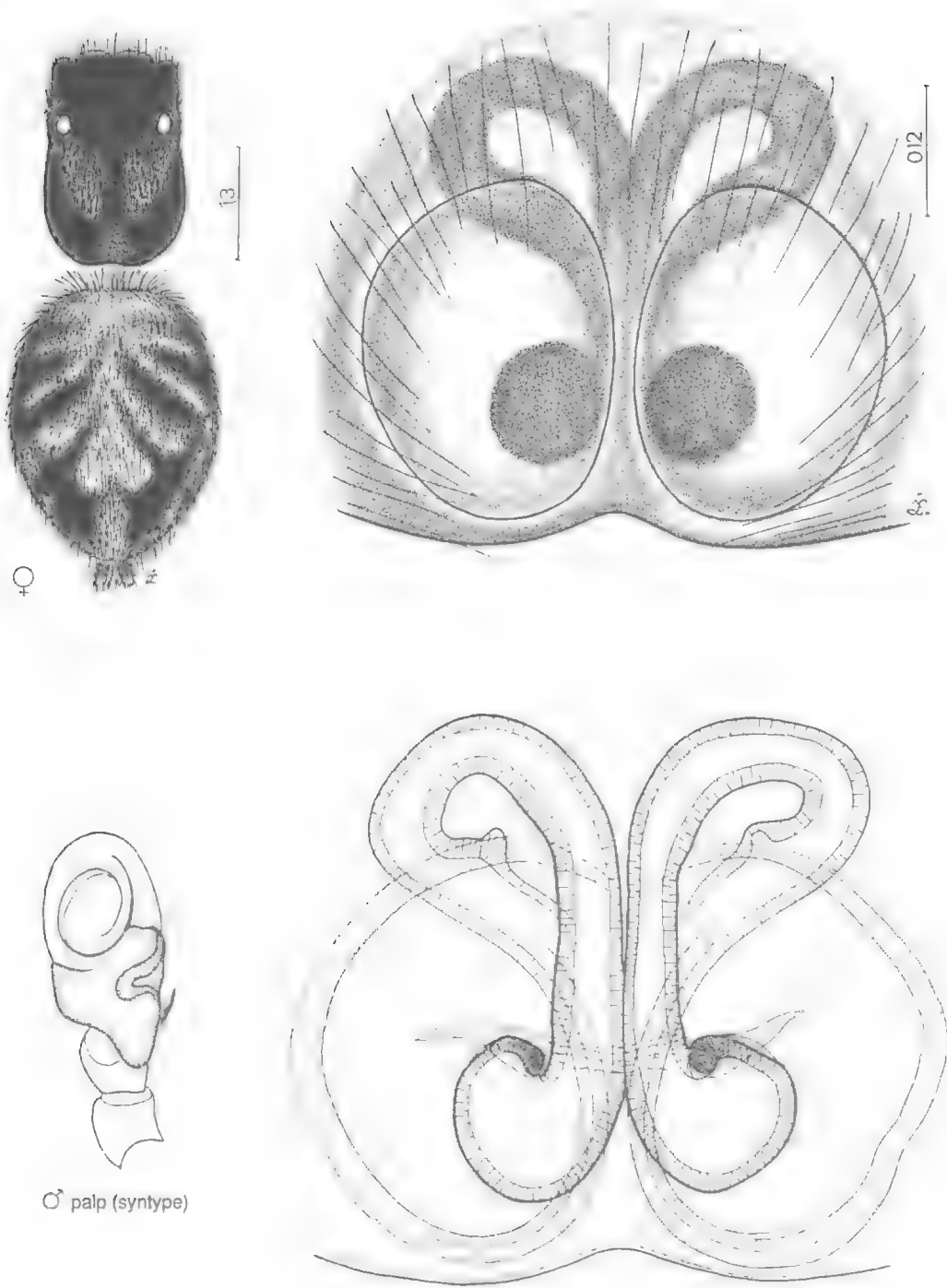
The type species of the small spider, *Lauharulla*, ♀ *L. pretiosa* has not been located nor have fresh specimens been found. From the illustrations (Koch and Keyserling *loc. cit.*) the sternum is shown to be as wide as long, otherwise it appears close to the above genera.



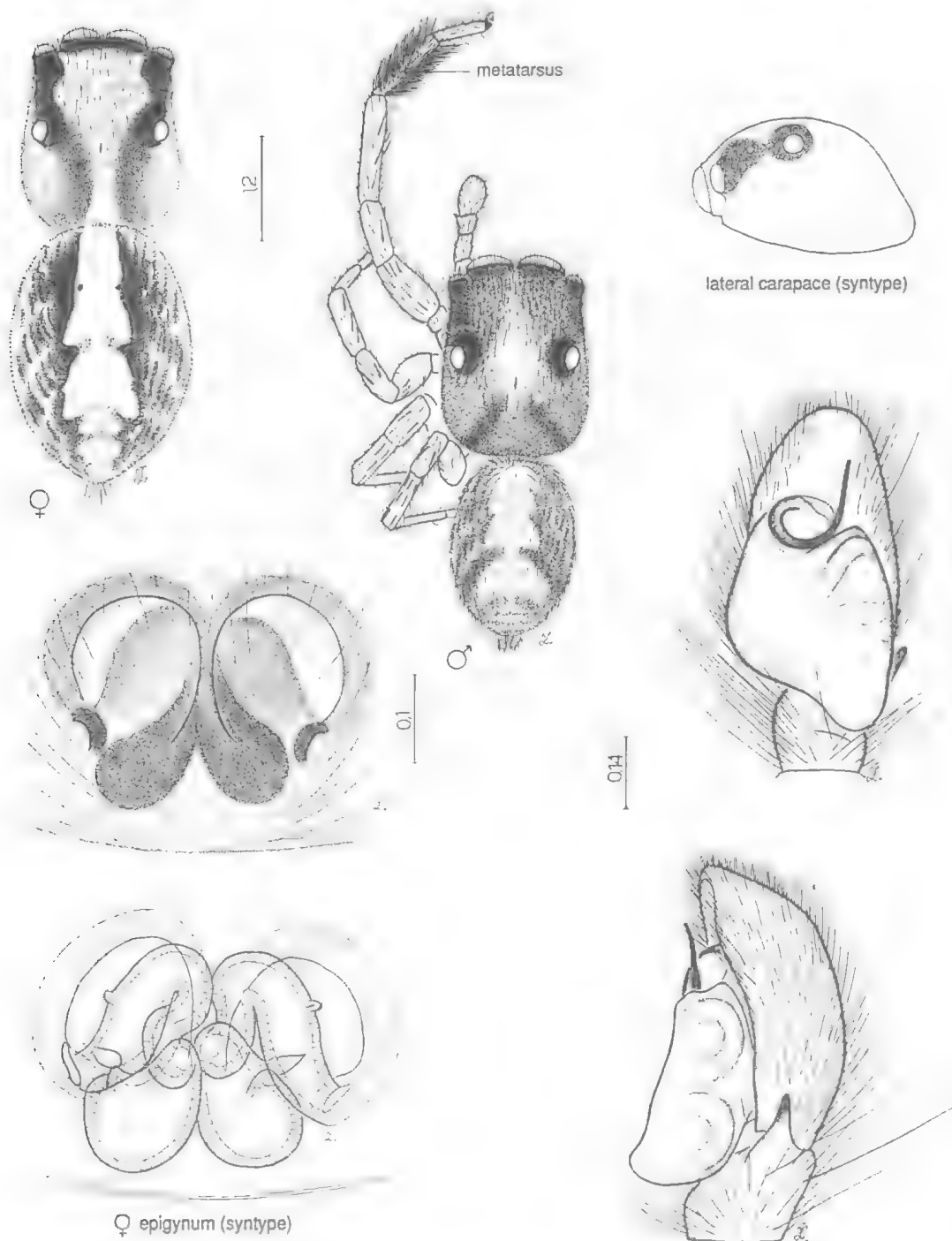
41. LYCIDAS SP. loc. Brisbane, southeast Queensland

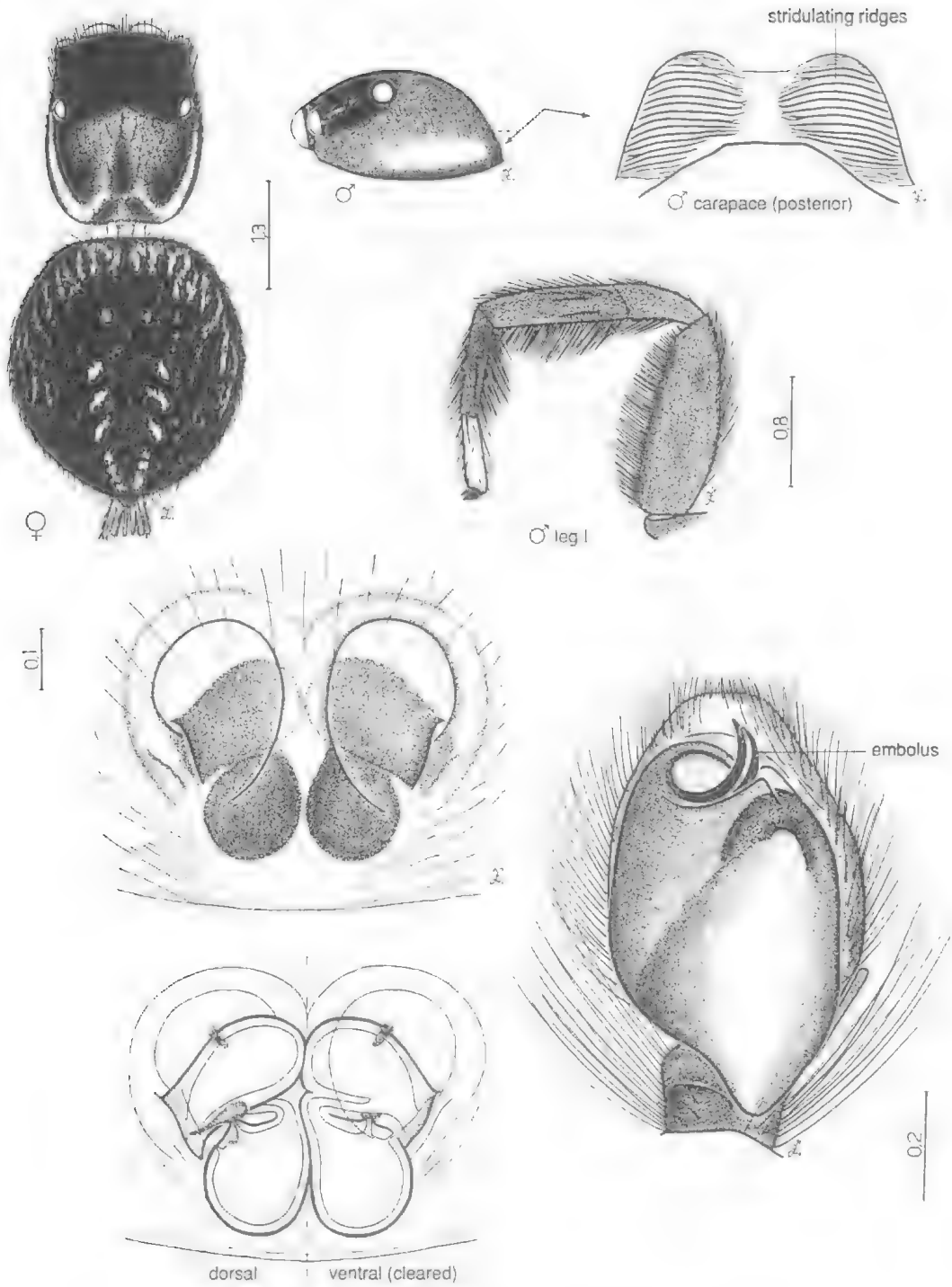


42. HYPOBLEMUM SP. loc. Cedar Creek, Samford, southeast Queensland.

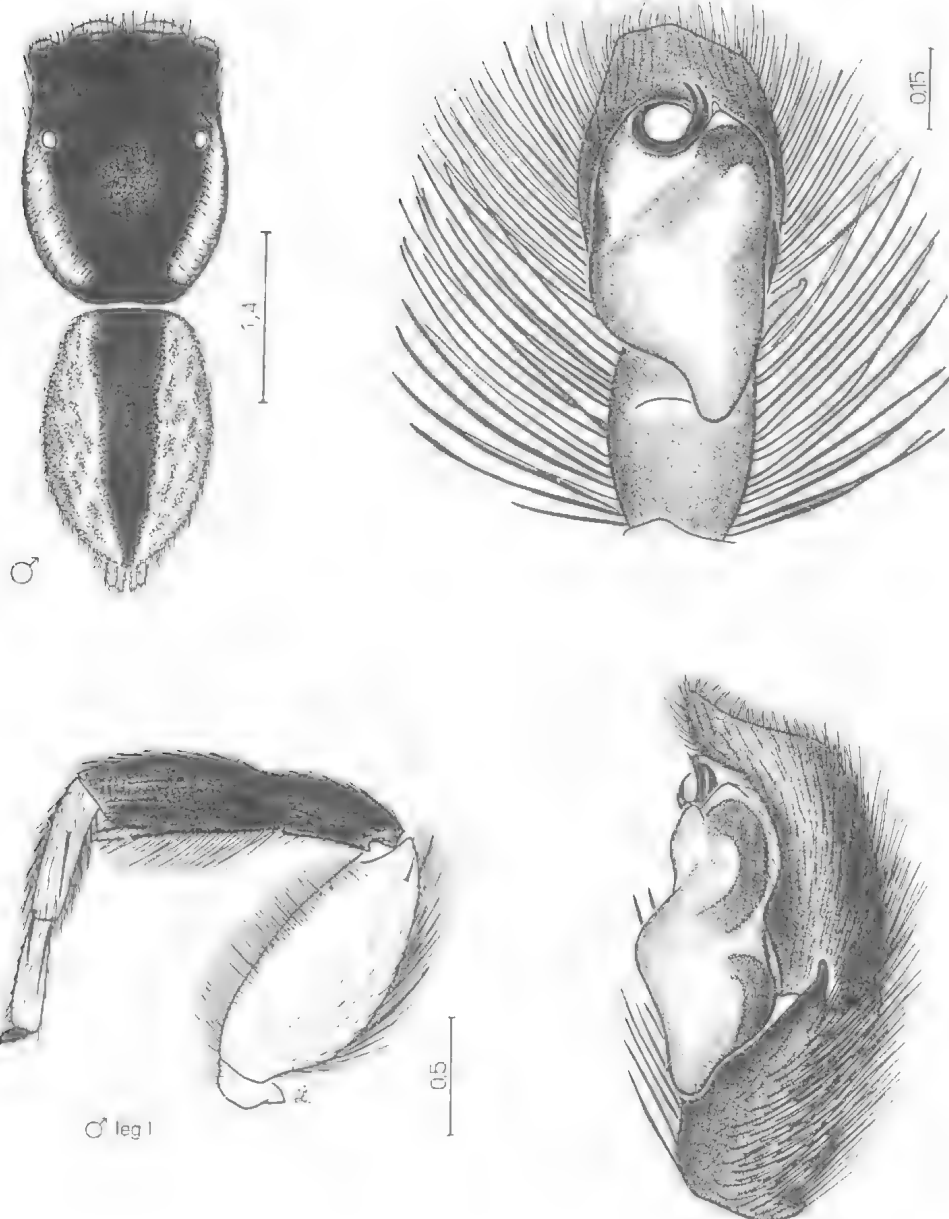


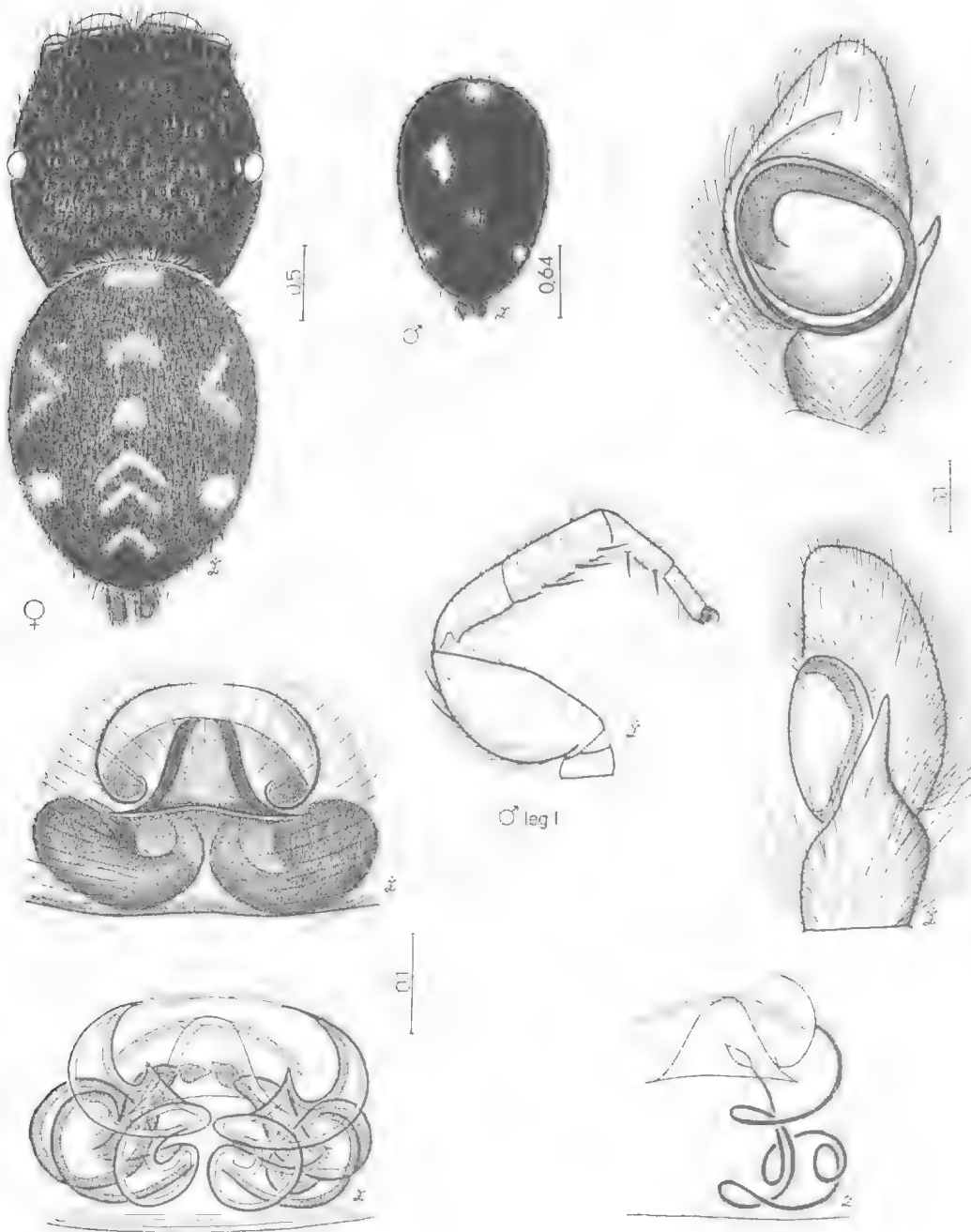
43. 'SALPESIA' SQUALIDA (KEYSERLING, 1883)

44. *PROSTHECLINA PALLIDA* KEYSERLING, 1882 *



45. 'LYCIDAS' MICHAELSENI (SIMON, 1909)

46. *JOTUS AURIPES* L. KOCH, 1881 *



47. *BIANOR MACULATUS* (KEYSERLING, 1883) *

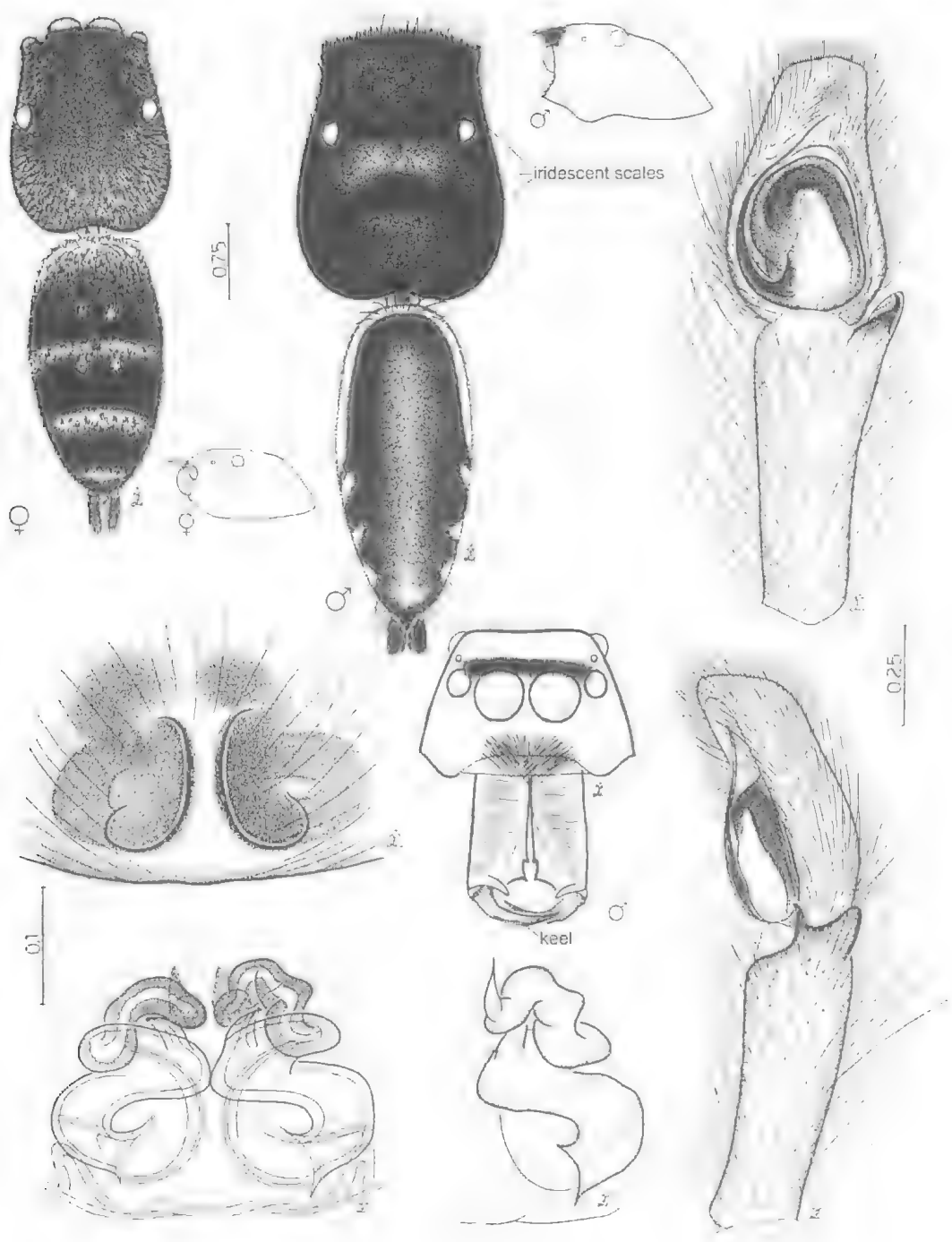
13. Ocular quadrangle much wider behind than in front. PLE on tubercles. Carapace widest at PLE
(Pl. 47) *Bianor*
- Ocular quadrangle about equal or narrower behind than in front. PLE rarely on tubercles. Carapace
rarely widest at PLE14
14. Iridescent scale-like hairs often arranged in bands on body. ♂ embolus spiniform, arising postero-
laterally, often longer than bulb. ♀ spermathecae anterior to fossae (Pl. 48) *Cosmophasis*
(northern Australia)
- Iridescent scale-like hairs if present not arranged in bands on body. ♂ embolus usually otherwise.
♀ spermathecae usually posterior to fossae15
15. ♂ tegulum wider than long with prolateral keel. ♀ epigynal plate longer than wide
..... (Pl. 49) *Plexippus*
(northern Australia)
- ♂ tegulum not wider than long, without keel. ♀ epigynal plate as wide or wider than long16
16. Cephalothorax moderately high, sides rounded17
- Cephalothorax low, sides more or less parallel19
17. ♂ tegulum with posterior lobe; embolus spiniform; tibial apophysis slender, bifurcate. ♀ posterior
epigynal margin strongly indented with slender median projection (Pl. 50) *Frigga*
(introduced)
- ♂ tegulum without posterior lobe; embolus short; tibial apophysis thick, undivided. ♀ posterior
epigynal margin slightly indented without median projection18

Bianor maculatus is a small spider that has been collected by sweeping grassland or shrubs. It is certainly closely related to *Harmochirus*, a fissident spider (see Pl. 22).

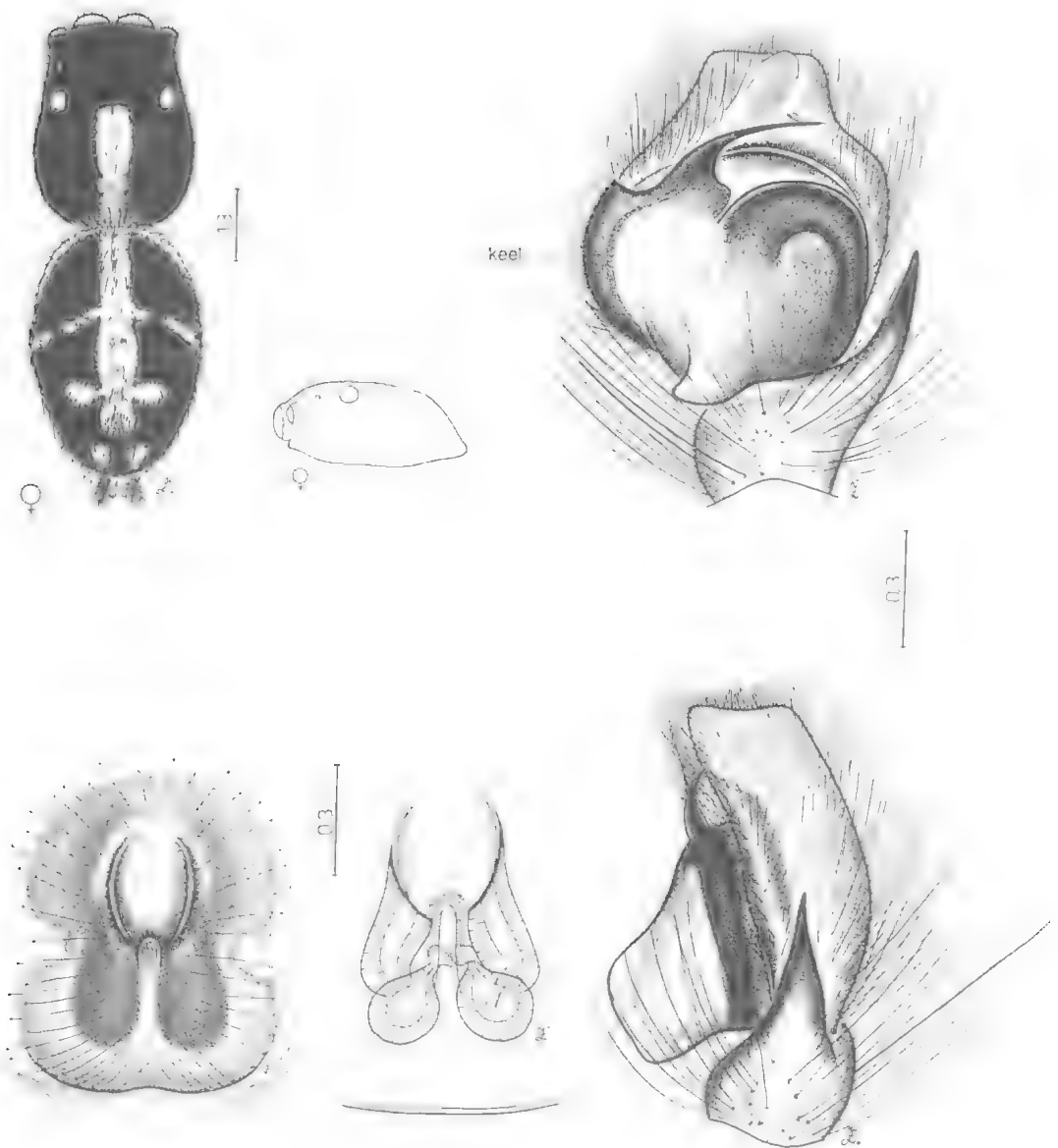
Cosmophasis is a very active spider which has multi-coloured iridescent scale hairs on the carapace, abdomen and palps. These hairs are easily removed and often hard to see in preserved specimens. Several males have been described from tropical Queensland. The ♂ illustrated resembles *C. micans* in pattern and in the presence of a low keel on the fangs but has a lower clypeus than that illustrated in Koch and Keyserling (*loc. cit.*). Main (1976, Colour plate, fig. 24) shows the ♀ (as *Saitis*) and calls it the Peacock Spider. Mascord (1970, Pl. 9, fig. 34) shows the ♂. Jackson (1986c) studied the display behaviour of this spider (as *C. micarioides*) and found that it uses one of three different mating tactics depending on the female's maturity and location. She may be encountered away from her nest, in the nest or as a sub-adult in her nest, in which case the ♂ builds a second chamber on the nest and co-habits until she moults and matures. Jackson (1987) further discusses the positive response that *Cosmophasis* spp. gave in relation to pheromones on silk as releasers of salticid courtship.

Plexippus paykullii and *P. petersii*, large tropical spiders, are the only two species of the genus known from Australia, although many spiders have been described in or transferred to this genus.

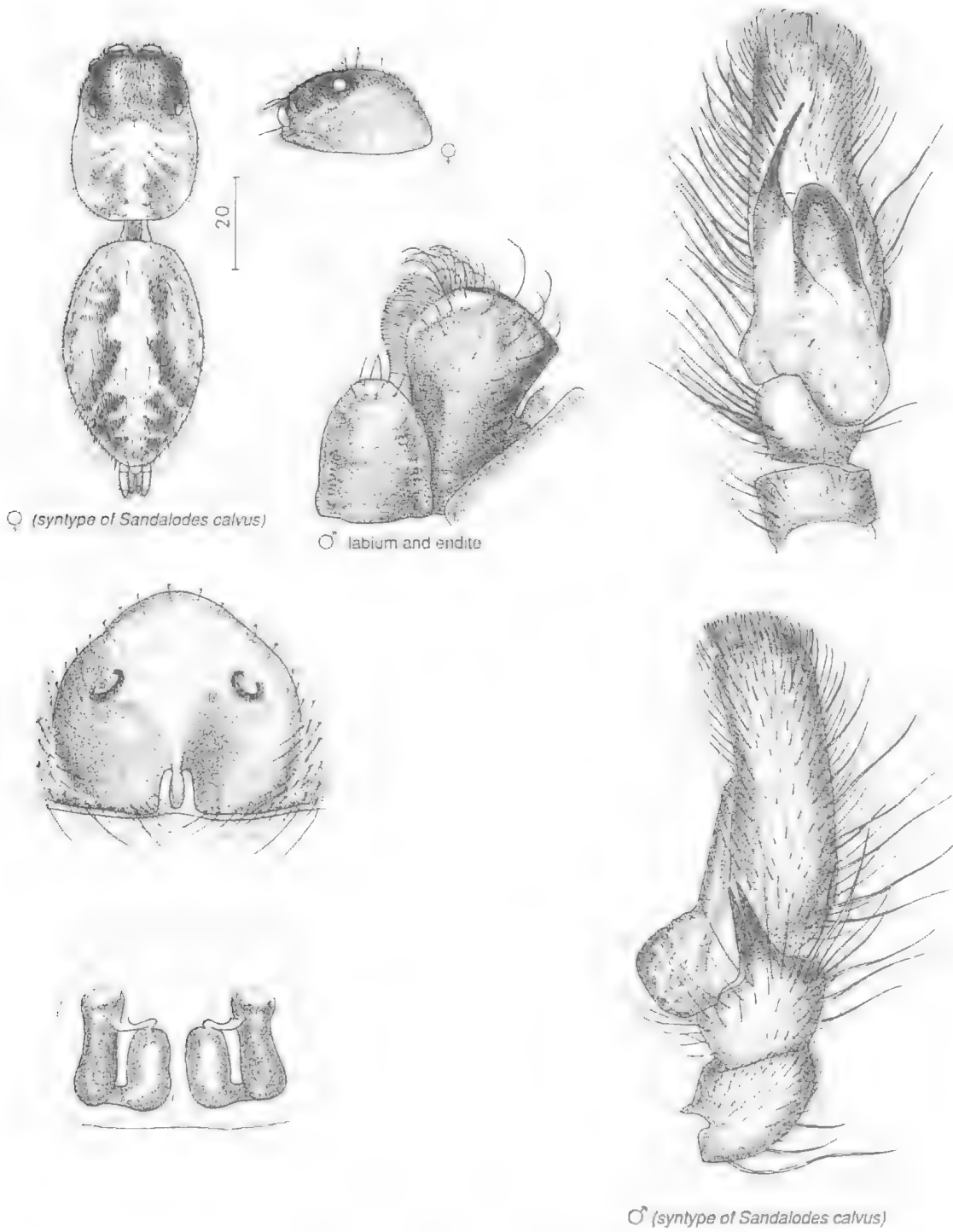
Galiano (1979) synonymised *Sandalodes calvus* Simon with *Frigga crocuta*. It is a large cosmopolitan spider, of which no fresh material has been collected. The types of *S. calvus* (from MNHP) are drawn.



48. COSMOPHASIS SP. loc. Clifton Beach, north Queensland



49. PLEXIPPUS PAYKULLII (SAVIGNY & AUDOUIN, 1827) *



50. FRIGGA CROCUTA (TACZANOWSKI, 1879)

18. Carapace much wider than PLE. Pale green spider with 2 dark longitudinal lines on abdomen. ♀ epigynum with paired fossae, broad median guide; spermathecae level with fossae (Pl. 51) *Mopsus*
 - Carapace not much wider than PLE. Colour otherwise. ♀ median fossa, spermathecae anterior to fossa (Pl. 52) *Sandalodes*
19. Lateral tufts of setae below ♀ PME. Striae on *pars thoracica*. Femur I not flattened20
 - Without lateral tufts of setae below ♀ PME. Rarely striae on *pars thoracica*. Femur I laterally flattened21
20. ♂ embolus very long, coiled round tegulum; tegulum rounded with pronounced apophysis. Tibial apophysis pointed. ♀ small median epigynal fossa. Eye tufts absent in ♂ (Pl. 53) *Gangus* (probably introduced)
 - ♂ embolus short, bifid; tegulum with lobe posteriorly; without apophysis. Tibial apophysis bifurcate. ♀ gonopores slit-like and widely separated. Eye tufts present in ♂ (Pl. 54) '*Trite*' *longula*
21. *Pars cephalica* rising gradually to PLE. ♂ embolus short, running clockwise (in left palp)22
 - *Pars cephalica* almost flat to PLE. ♂ embolus short or long, anti-clockwise25
22. Band of white hair above lateral edge of carapace. Dorsal abdomen pale. ♂ embolus blunt; membranous conductor. ♀ with large, shallow epigynal fossae, 0.2 × length of abdomen; gonopores separated (Pl. 55) *Menemerus* (introduced)
 - Without band of white hair around carapace. Pale longitudinal median band on dorsal abdomen. ♂ embolus spiniform; without conductor. ♀ with small median epigynal fossa, sometimes absent; gonopores adjoining23

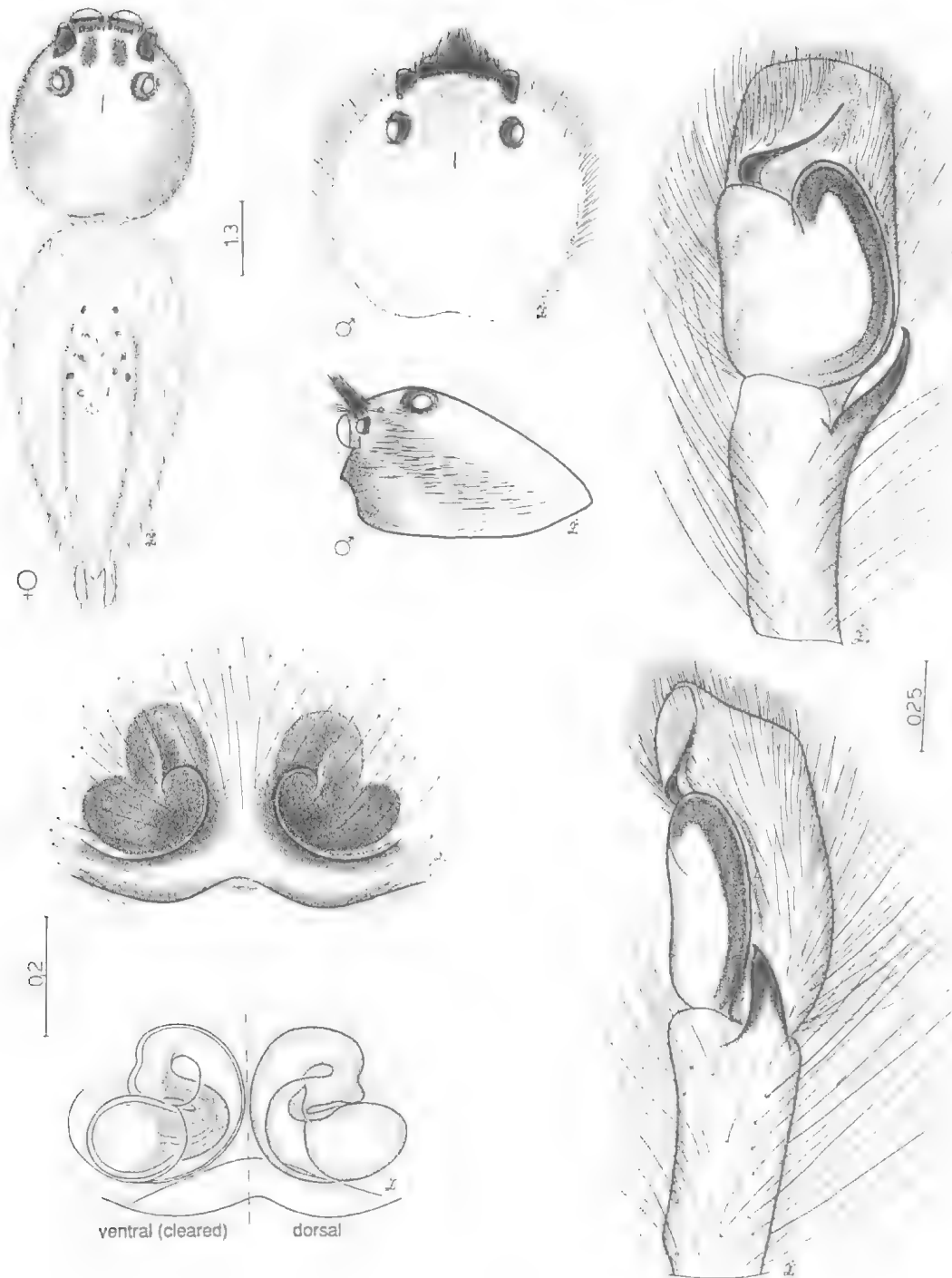
Mopsus mormon, a large and beautiful green spider, is widely distributed in northern Australia. Smaller specimens may occasionally be found as far south as New South Wales. Jackson (1983) found that *Mopsus*, like *Cosmophasis* has three different mating tactics depending on the female's maturity and location. Jackson (1987) discusses non-visual stimuli (pheromones on silk) as releasers of salticid courtship in several genera from different families. *Mopsus* gave a positive response. Main (1976, Colour plate, fig. 23) shows ♂ *M. mormon* and Mascord (1970, Plate 8, figs 29,30) illustrates ♂ and ♀ (as *M. penicillatus*).

Sandalodes bipenicillatus, a large spider, was originally described in *Mopsus*. It was chosen by Keyserling as the type species of the genus, *Sandalodes*. The spider (as *Bavia ludicra*) in Mascord (1970, Plate 11, figs. 39, 40) is probably *Sandalodes* also.

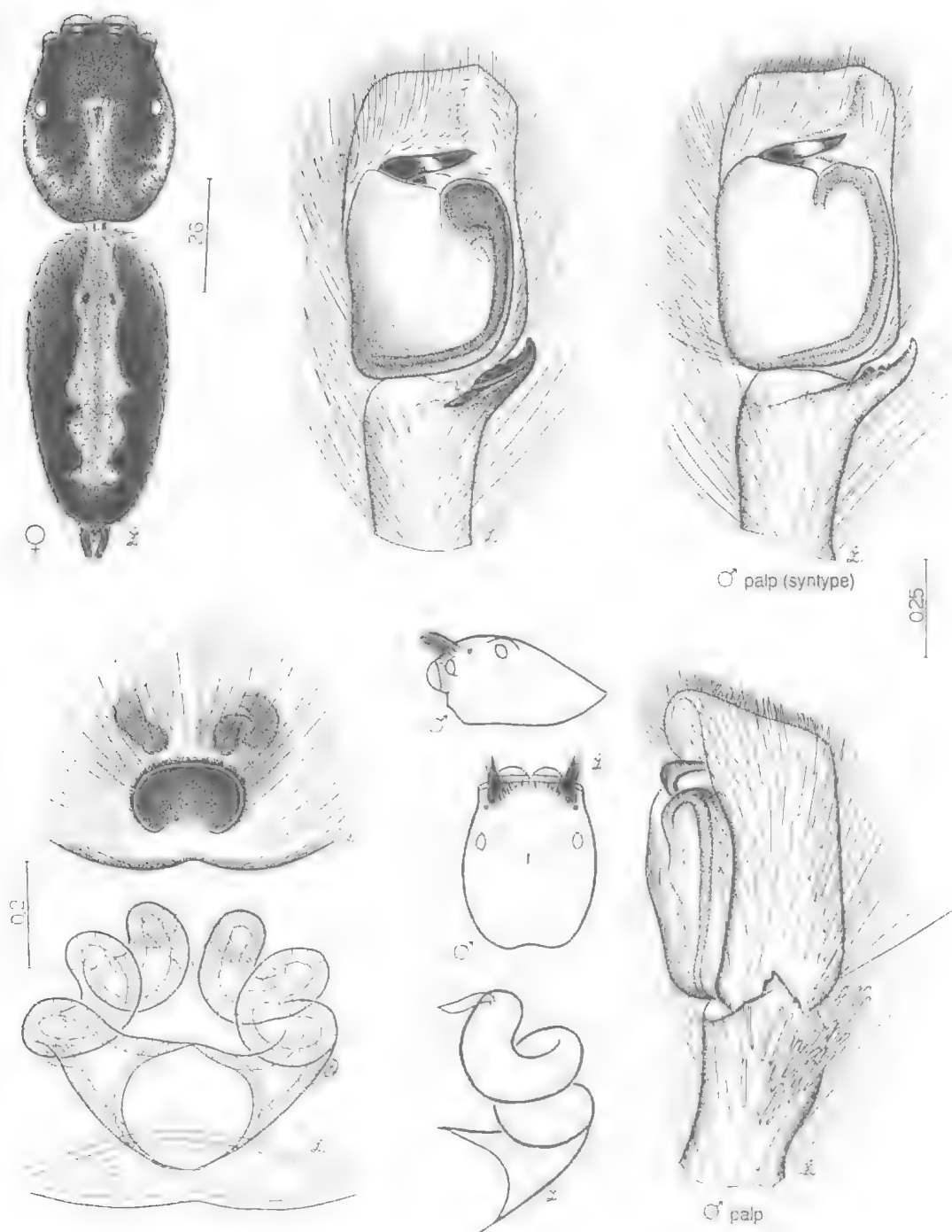
Gangus concinnus is a slender, silvery medium-sized spider common in grassland along eastern Australia north to the Torres Strait Is. It was described as *Acompse concinnus* by Keyserling and later chosen by Simon (1897-1903: 706) as the type species of *Gangus*. In published posthumous notes, Clarke (1974) suggested it was a synonym of *Mithion hesperius* which Prószyński (1987 *in index*) transferred to *Thyene*, though *Mithion* is the earlier name. Prószyński (pers. comm.) has submitted a proposal to the International Commission of Zoological Nomenclature to suppress the older name and retain *Thyene*. We have retained *Gangus* as a valid name for the meantime.

Trite, the type species of which is *T. pennata* from New Caledonia is a fissident spider allied to *Opisthoncus*. '*Trite*' *longula*, on the other hand, is a unident spider from Cape York Peninsula which was first described as *Marptusa longula* by Thorell. Simon (1897-1903: 829) suggested it perhaps belonged in *Trite* and it has remained there since. It is almost certainly the same spider as *Gangus longulus* Simon which is not congeneric with *Gangus concinnus*.

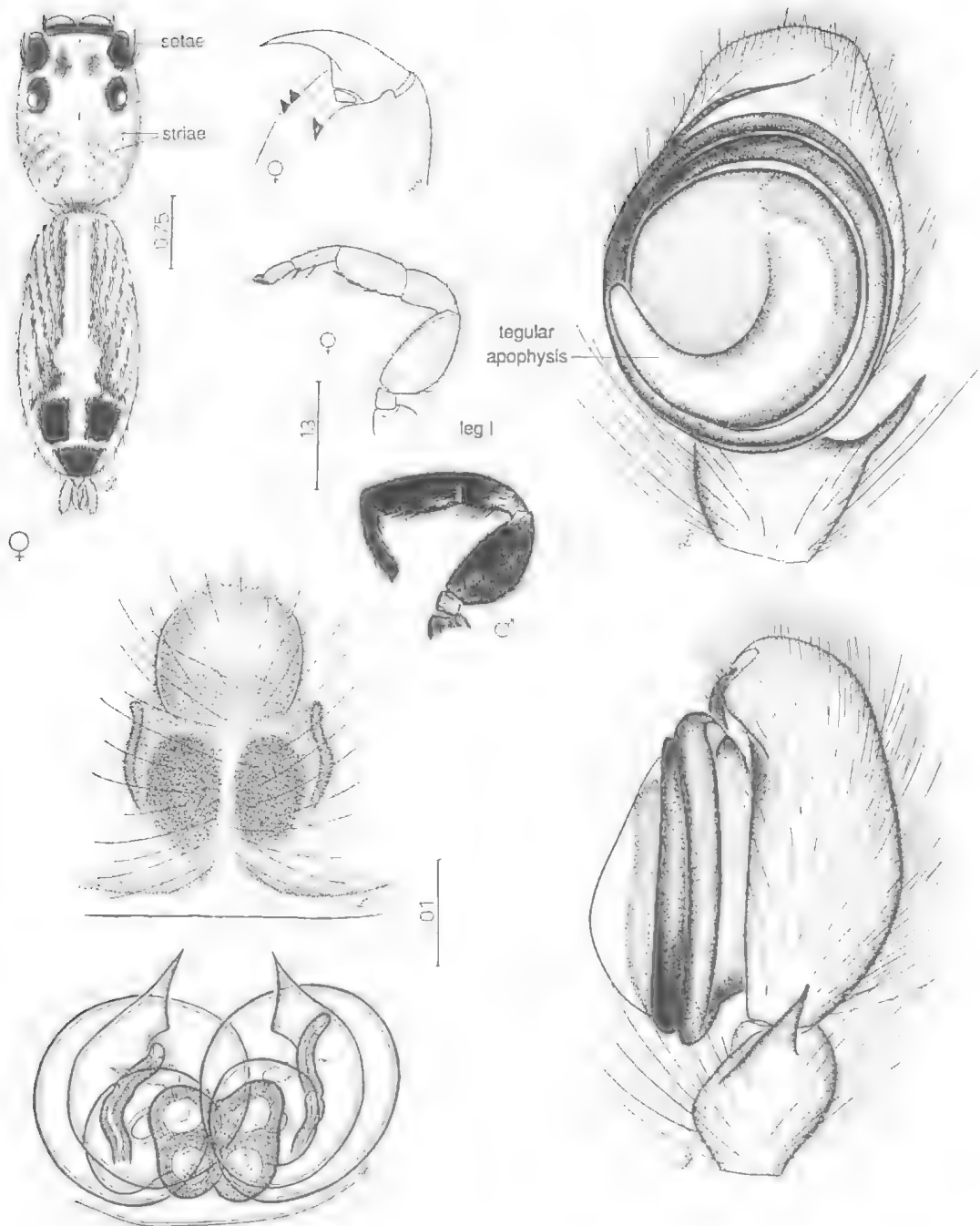
In all the following genera, femur I is laterally flattened. *Menemerus bivittatus* is a cosmopolitan spider which is often found in buildings in eastern Australia.



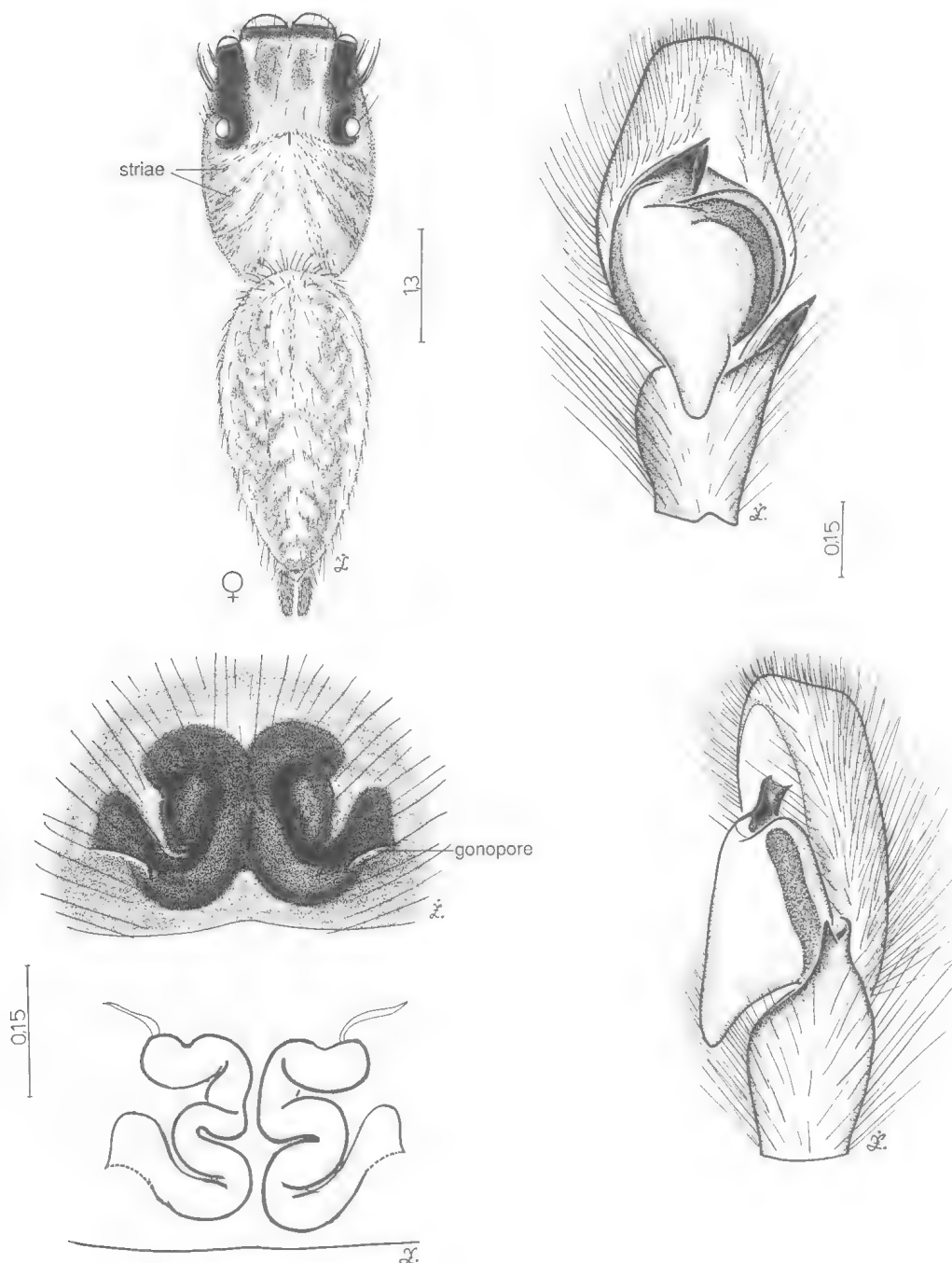
51. MOPSUS MORMON KARSCH, 1878 *



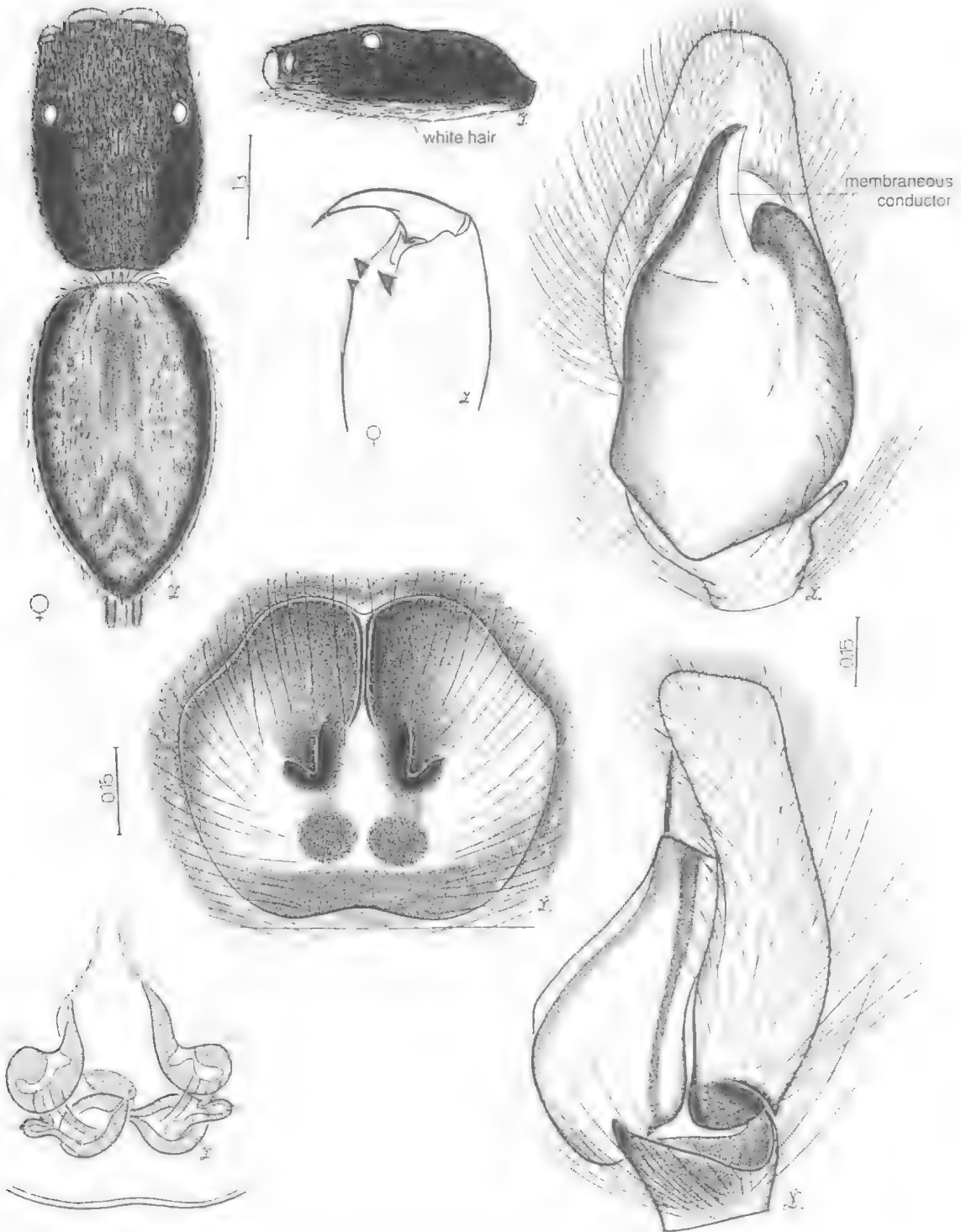
52. SANDALODES BIPENICILLATUS (KEYSERLING, 1882) *



53. GANGUS CONCINNUS (KEYSERLING, 1881) *



54. 'TRITE' LONGULA (THORELL, 1881)



55. MENEMERUS BIVITTATUS (DUFOUT, 1831)

23. Tibia I with 3 regular retrolatero-ventral spines. ♂ endite with retrolateral protuberance (Pl. 56) *Clynotis*
 Tibia I with 3 reduced retrolatero-ventral spines or none. ♂ endite rounded 24
24. Tibia I with 3 short prolatero-ventral spines only. ♂ femur, patella, tibia I fringed. ♂ chelicera bowed. ♂ tibial apophysis blunt (Pl. 57) '*Menemerus*' *bracteatus*
 Tibia I without spines. ♂ leg I without fringes. ♂ chelicerae not bowed. ♂ tibial apophysis pointed (Pl. 58) '*Breda*' *jovialis*
25. Tibia I with 3 pairs of ventral spines. ♂ tegulum with posterior lobe 26
 Tibia I with 2-3 prolatero-ventral spines only or none. ♂ tegulum without posterior lobe 27
26. *Pars thoracica* with 4-6 lines of white hair radiating back from foveal region. ♂ embolus short. ♂ endite without retrolateral protuberance (Pl. 59) '*Clynotis*' *albobarbatus*
Pars thoracica without lines of white hair. ♂ embolus very long passing across ventral surface of tegulum and then along edge of elongate cymbium. ♂ endite with retrolateral protuberance (Pl. 60) '*Trite*' *daemeli*
27. Medium-sized spiders. Pair of small, shallow, cephalic depressions between PLE and wider depressed area behind these. Rarely any spines on tibia I (Pl. 61) *Holoplatys*
 Large spiders. Without paired cephalic depressions between PLE. Two prolatero-ventral spines on tibia I (Pl. 62) *Ocrisiona*

Icius viduus Koch was chosen by Simon (1897-1903: 611) as the type species of *Clynotis*. *Clynotis viduus*, a medium-sized spider, is found under the bark of eucalypts. Zabka (1987a) gives a short redescription of the types. The spider from Lake Broadwater (see drawings of habitus, cephalothorax and chelicera) may not be *C. viduus*, *s. strict.*

'*Menemerus*' *bracteatus* is a large spider found under the bark of eucalypts. The small pale patch on the chelicera appears to be present in all salticids. This spider lacks the large ♂ fossae and ♂ conductor of *Menemerus*.

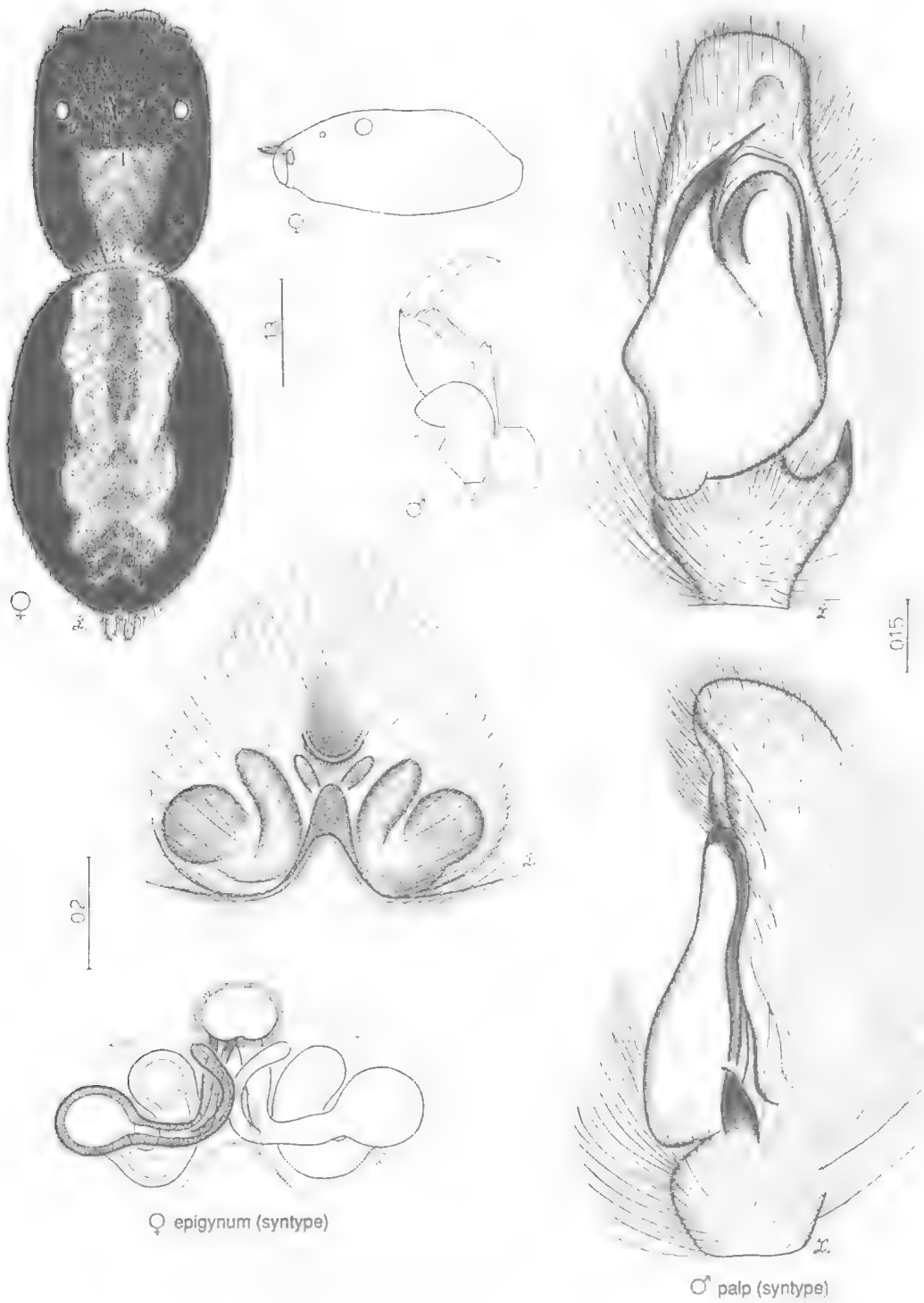
'*Breda*' *jovialis* is usually smaller than '*M.*' *bracteatus* and may be beaten from foliage or taken from under bark. Mascord (1970, Pl. 9, fig. 33) shows the characteristic yellow marking on the dorsal abdomen. There are several undescribed species and that illustrated may not be *jovialis s. strict.* The ♂ palp of the Central American genus, *Breda* has a long tibial apophysis and long embolus arising posteriorly, quite unlike this spider.

Icius albobarbatus was transferred to *Clynotis* by Rainbow (1911) in his catalogue. Zabka (1987a) redescribed the types as *Clynotis albobarbatus*. '*Clynotis*' *albobarbatus* is now seen, by its different habitus, epigynum and embolic pattern, to belong to a different genus from *Clynotis*. It has several species, most of which are found in litter.

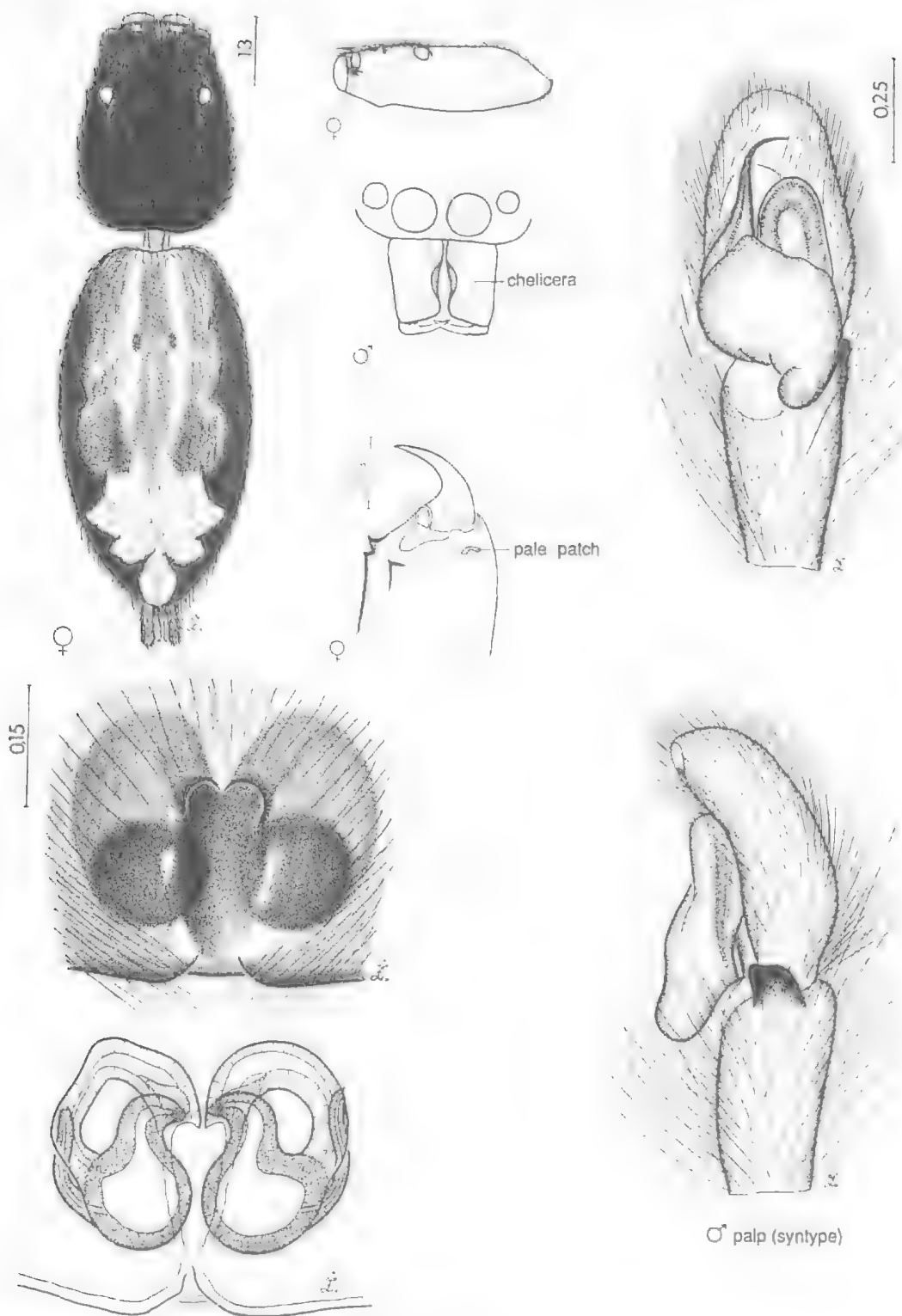
Trite, as mentioned earlier, is a fissident spider allied to *Opisthoneus*. '*True*' *daemeli*, on the other hand, is a distinctive unident spider with very long embolus, very large epigynum and characteristic endite and fang. There are several undescribed species like *daemeli* and the ♂ specimen illustrated shows slightly different cheliceral dentition from that of Koch and Keyserling (*loc. cit.*), thus it may not be *daemeli s. strict.* The ♂ holotype has not been located. This is the first time the ♂ has been illustrated.

Simon (1885: LXXXIX) chose *Marptusa planissima* L. Koch to be the type species of *Holoplatys*. *Holoplatys* is a very flat, medium-sized spider usually found under the bark of eucalypts. Mascord (1970, Pl. 10, fig. 38) shows ♂ *Holoplatys*. Jackson and Harding (1982) studied the intraspecific interaction of a New Zealand species and found that the ♂ had three different mating tactics depending on the female's age and location. Jackson (1987), comparing the releaser pheromones associated with the silk, found that two *Holoplatys* spp. were the only spiders of the 36 tested that did not respond to the nest of conspecific females.

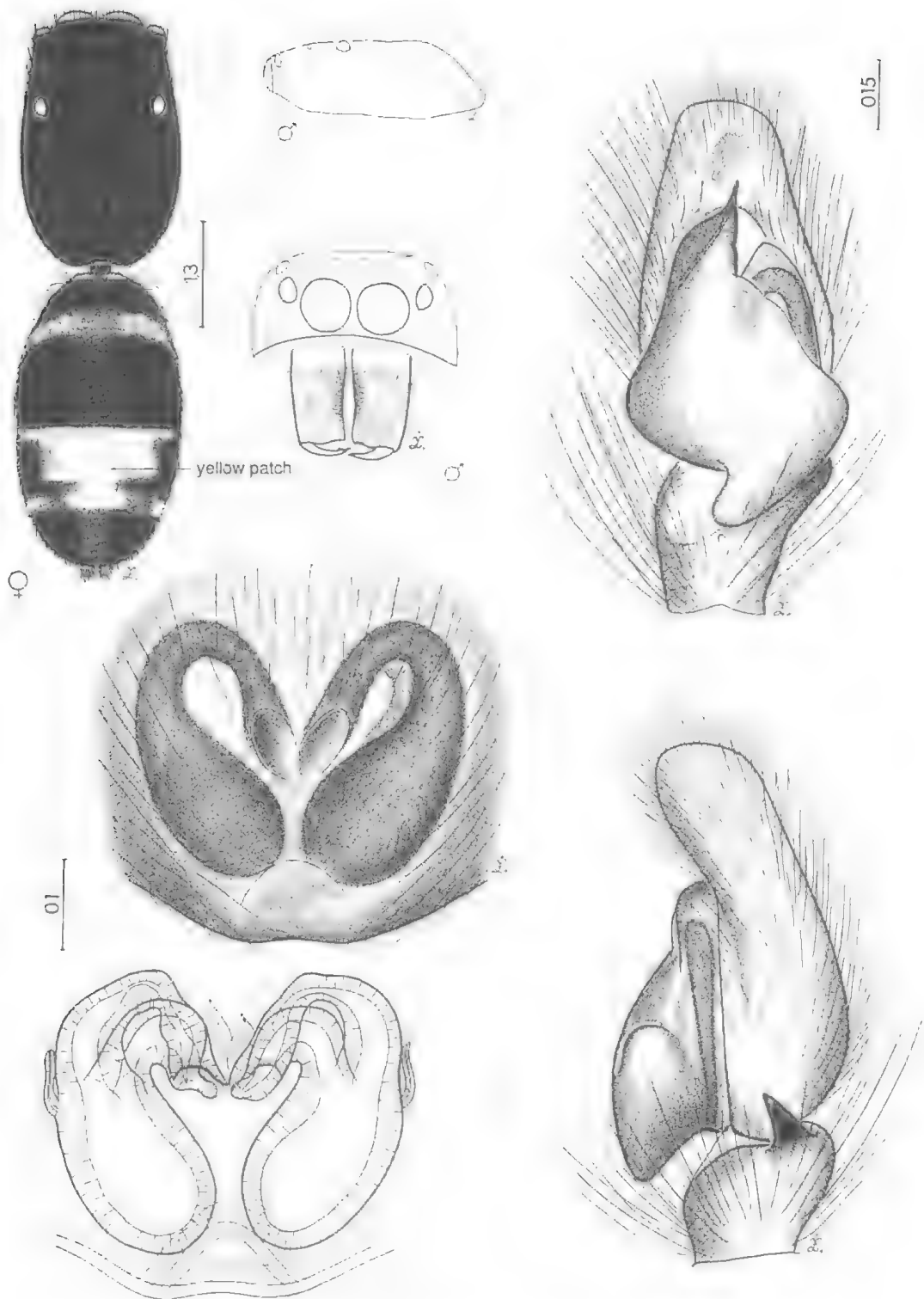
Simon (1897-1903: 609) chose *Marptusa leucomis* L. Koch to be the type species of *Ocrisiona*. *Ocrisiona* is a large spider which lacks the paired cephalic depressions of *Holoplatys*; it is found in similar locations, under bark or beaten from foliage. Mascord (1970, Pl. 11, fig. 41) shows ♂ and ♀ *Ocrisiona*. The syntype illustrated is from Port Mackay, a locality not listed by Keyserling (Koch and Keyserling *loc. cit.*) so it may not be *O. leucomis s. strict.*



56. CLYNOTIS VIDUUS (L. KOCH, 1879) *

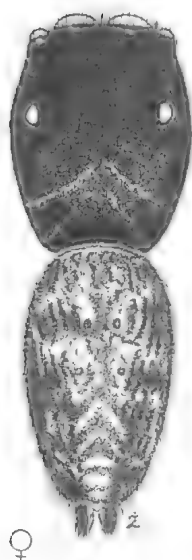


57. 'MENEMERUS' BRACTEATUS (L. KOCH, 1879)



58. 'BREDa' JOVIALIS (L. KOCH, 1879)

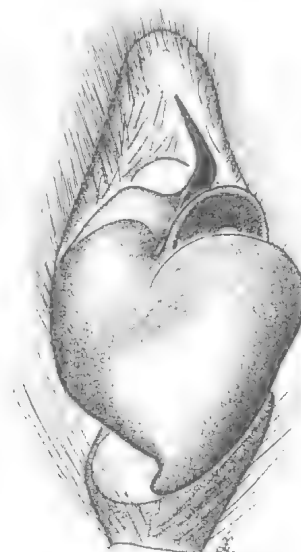
*This is the *rt* ♂ palp; the *l* embolus is not anti-clockwise as stated in the key.



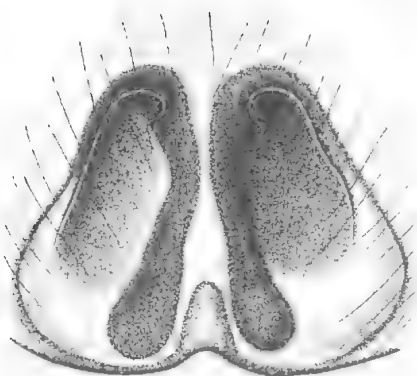
0.13



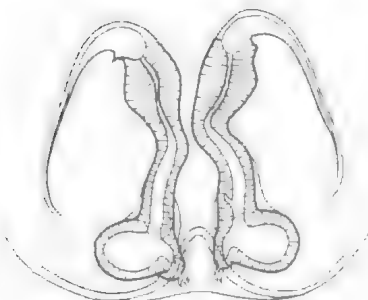
♂ labium and endite



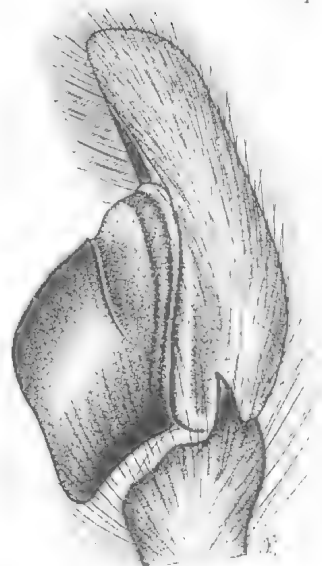
0.15



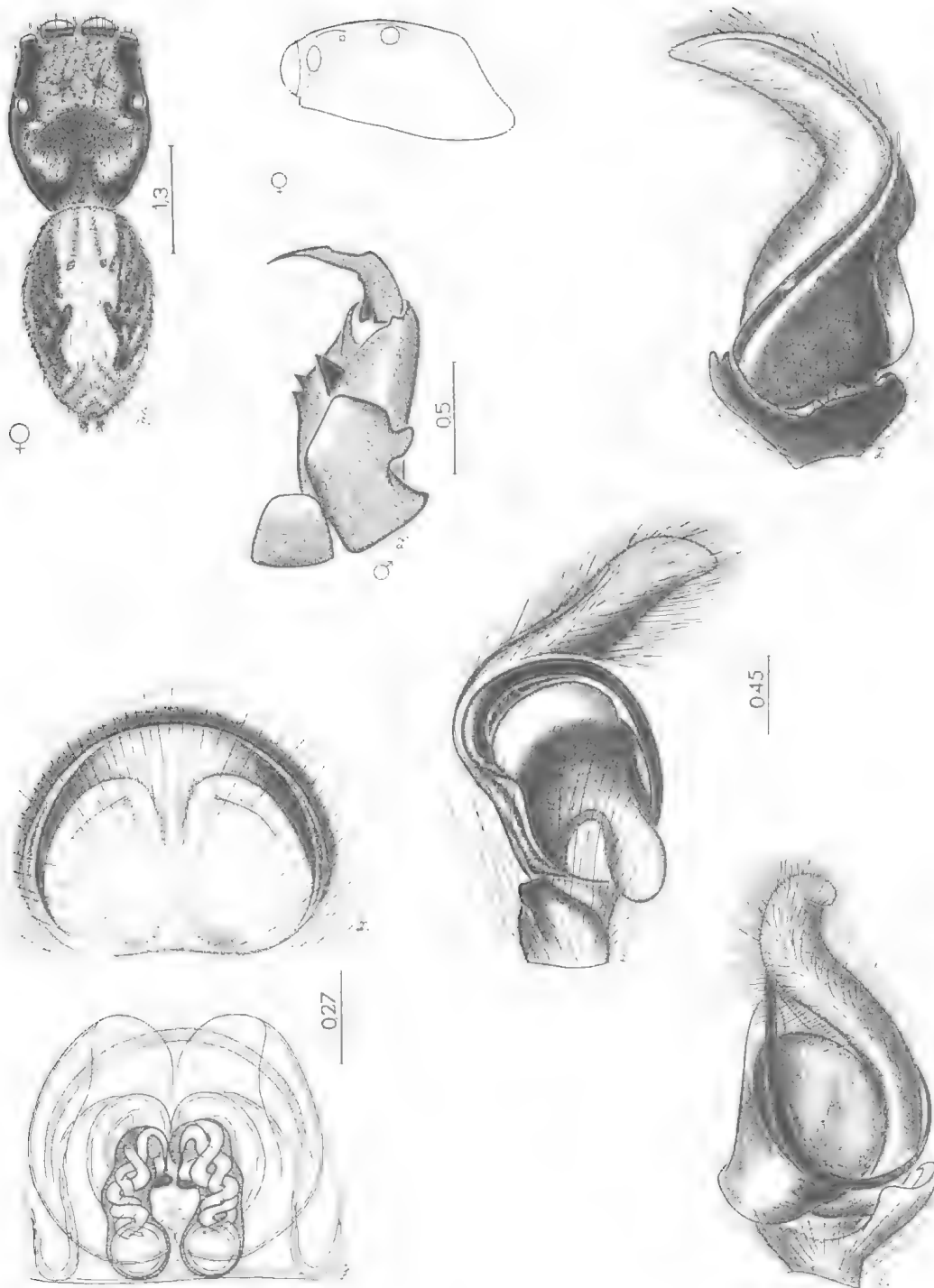
0.15



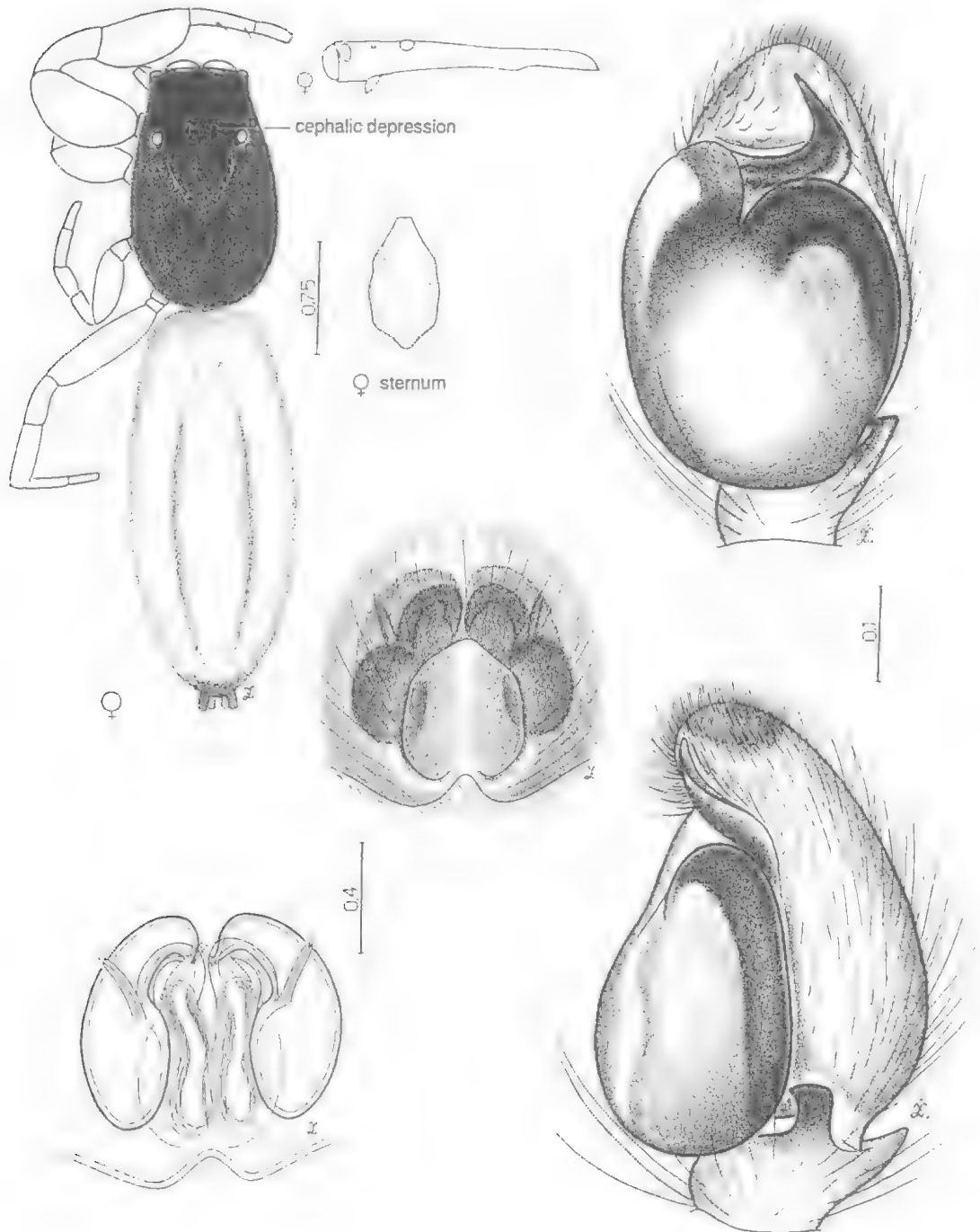
♀ epigynum (syntype)



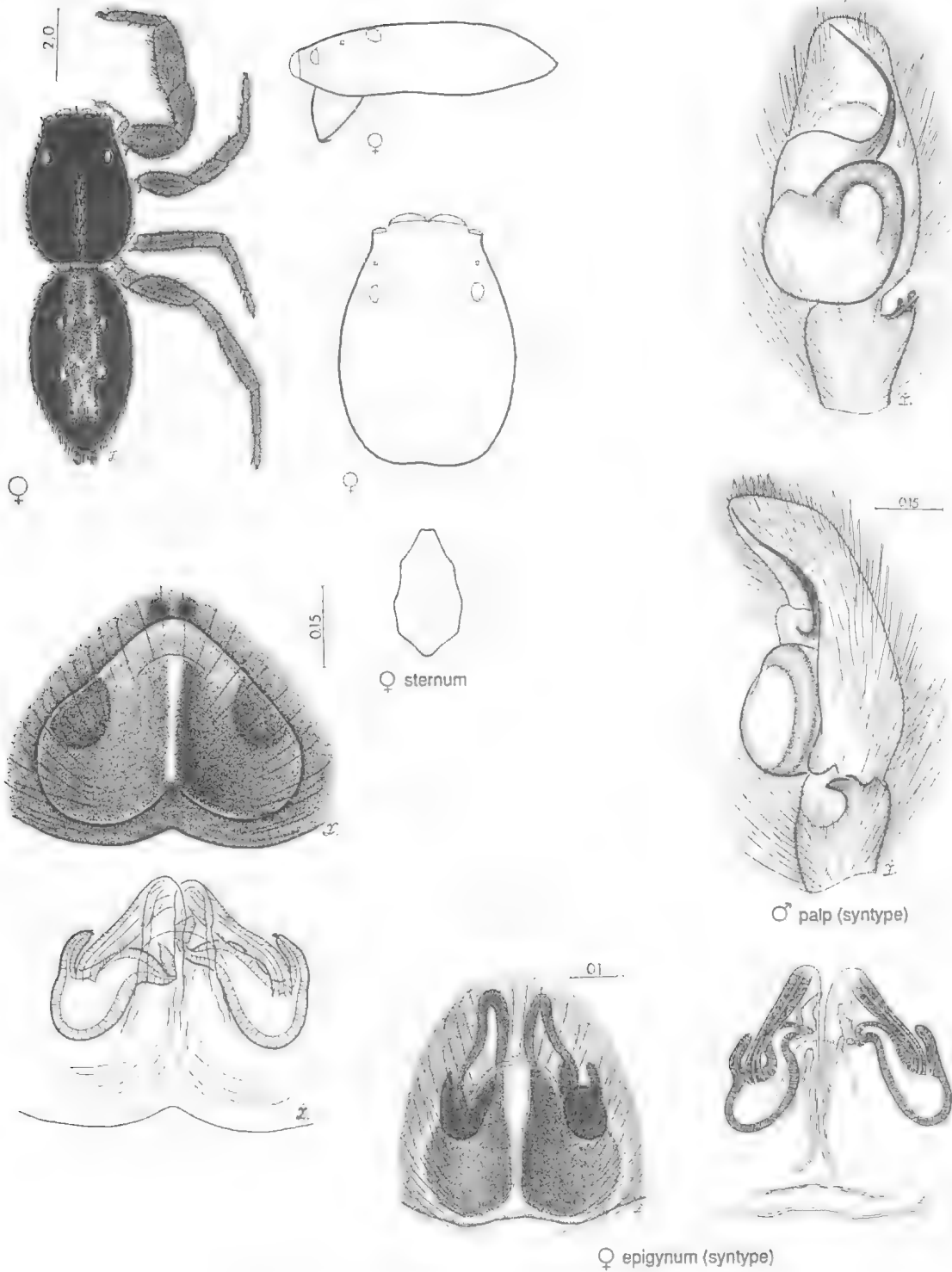
♂ palp (syntype)



60. 'TRITE' DAEMELII (KEYSERLING, 1883)



61. HOLOPLATYS PLANISSIMA (L. KOCH, 1879) *



62. *OCRISIONA LEUCOCOMIS* (L. KOCH, 1879) *

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APPENDIX

A list of the spiders that are illustrated, their geographical localities and the Museums in which the type specimens, that have been examined, are located. Unless indicated, the rest of the material is from the collections in the Queensland Museum.

PLURIDENTATI

- Arasia mollicoma* ♂ syntype, Bowen, MEQ (ZMH); ♀ (AM).
- Astia hariola* ♀ ♂, Lake Broadwater nr Dalby, SQ.
- Bavia aericeps* ♀ ♂, Cape Tribulation, NEQ.
- Cocalus gibbosus* ♂ holotype, Lockerbie, Cape York, NQ (QM); ♀, Shiptons Flat, NQ.
- Copocrossa tenuilineata* ♀, Mission Beach, NEQ.
- Cyrba ocellata* ♀, Wilson Is., MEQ; ♂, Wharton Reef, Great Barrier Reef, NEQ.
- Damoetas nitidus* ♂ syntype of *Scirtetes nitidus*, Sydney, NSW (ZMH), ♂ palp; ♀, Oatley Park, Sydney, NSW (AM); ♂, Rochedale, Brisbane, SEQ, other drawings.
- Helpis minitabunda* ♀ ♂, Noosa, SEQ.
- Jacksonoides kochi* ♀ ♂, Home Rule nr Helenvale, NQ (det. F. Wanless).
- Ligonipes* sp. ♀ ♂, Brisbane, SEQ.
- Ligonipes lacertosus* ♀, Somerset, Cape York, NQ.
- Ligonipes semitectus* ♀, syntype of *Haterius semitectus*, Cooktown, NEQ (ZMK).
- Mintonia* sp. ♀, Kuranda, NQ (AM); ♂ *M. tauricornis*, Sarawak, ♂ palp, after Wanless (1984).
- Myrmarachne* spp. ♀, Brisbane, SEQ; ♂, Goomeri, SQ.
- Portia fimbriata* ♀, Cairns; ♂ Cape Tribulation, NEQ.
- Rhombonotus gracilis* ♀ ♂, Lake Broadwater, nr Dalby, SQ.
- Sondra nepenthicola* ♂ holotype, ♀ paratype, Seary's Scrub, Cooloola, SEQ (QM).
- Tauala lepidus* ♂ holotype, ♀ paratype, Crystal Cascades nr Cairns, NEQ (QM).

FISSIDENTATI

- Adoxotoma nigroolivacea* ♀ syntype, Perth, WA (ZMB), epigynum and leg I; other illustrations of syntype after Wanless (1988).
- Canama hinnuleus* ♀, Airlie Beach, MEQ; ♂, Brandy Ck nr Proserpine, MEQ.
- Cytaea alburna* ♀, Trinity Beach, NEQ; ♂, Gin Gin, SQ.
- Diolenius* sp. ♀ ♂, Dividing Range, 15 km W Captain Billy Ck, Cape York, NQ.
- Ergane cognata* ♂ holotype, Pellew Islands, Gulf of Carpentaria, NT (ZMH), ♂ palp, chelicera; habitus copied from Koch & Keyserling (1871–1883).
- Euryattus bleekeri* ♀, Homevale, MQ, ♂, Cairns, NEQ.

- Harmochirus brachiatus* ? ♂, West Alligator River mouth, NT.
- Hasarius adansoni* ♀, Heron Is, MEQ; ♂, Brisbane, SEQ.
- Opisthoncus parcedentatus* ♀ ♂, Lake Broadwater nr Dalby, SQ.
- Servaea vestita* ♀ ♂, Lake Broadwater nr Dalby, SQ.
- Simaetha thoracica* ♀ ♂, Gordonvale, NQ.
- Simaethula* spp. ♀, Cape Tribulation, NEQ; ♂, Brisbane, SEQ.
- Tara anomala* ♂ holotype, Sydney, NSW (ZMH), ♂ palp; habitus copied from Koch & Keyserling (1871–1883). *Tara* sp. ♂, Mt Tenison Woods nr Brisbane, SEQ; habitus, ♂ palp.

UNIDENTATI

- Bianor maculatus* ♀ ♂, Lake Broadwater nr Dalby, SQ.
- '*Breda*' *jovialis* ♀ ♂, Brisbane, SEQ.
- '*Clynotis*' *albobarbatatus* ♀ ♂, syntypes, Sydney, NSW (ZMH); epigynum, ♂ palp. ♀, Gold Ck, Brisbane, SEQ, habitus.
- Clynotis viduus* ♂ ♂ syntypes of *Icius viduus*, Sydney, NSW, Peak Downs, MQ, Rockhampton, MEQ (ZMH), ♂ palp; ♀ syntype (ZMB), epigynum. ♀ ♂, Lake Broadwater nr Dalby, SEQ; habitus, other drawings.
- Coccorchestes ferreus* ♀ holotype, Iron Ra, Cape York, NQ (QM); ♂, Iron Ra, Cape York, NQ.
- Cosmophasis* sp. ♀ ♂, Clifton Beach, NEQ.
- Friga crocuta* ♀ ♂ syntypes of *Sandalodes calvus*, Cooktown, NEQ (MNHP).
- Gangus concinnus* ♀, Lake Broadwater nr Dalby, SQ; ♂, Murray Is., Torres Str. Is.
- Holoplatys planissima* ♀, Boobyjan via Tansey, SQ; ♂, Brisbane, SEQ.
- Hypoblemum* sp. ♀ ♂, Cedar Ck, Samford nr Brisbane, SEQ.
- Jotus auripes* ♂, Flat Rock, NSW (AM).
- Lycidas* sp. ♀ ♂, Brisbane, SEQ.
- '*Lycidas*' *michaelseni* ♀ ♂, Perth, WA.
- Maratus* sp. ♀ ♂, Rochedale, Brisbane, SEQ.
- Margaromma funestum* ♀ syntype, Cape York, NQ (BMNH).
- Menemerus bivittatus* ♀ ♂, Brisbane, SEQ.

- 'Menemerus' bracteatus* ♂ syntype, Rockhampton, MEQ (ZMH), ♂ palp, chelicerae. ♀, Lake Broadwater nr Dalby, SQ, habitus, epigynum.
- Mopsus mormon* ♀, Koah Rd, NEQ; ♂, Darwin, NT.
- Ocrisiona leucocomis* ♀ ♂, syntypes, Port Mackay, MEQ (BMNH), epigynum, ♂ palp. ♀, Botany, NSW (AM), habitus, epigynum.
- Omoedus* sp. ♀ ♂, Iron Range, NQ.
- Palpeliu beccarii* ♂, Lockerbie, Cape York, NQ; ♀, Bamaga, Cape York, NQ.
- Plexippus paykullii* ♀, Forth Is, Great Barrier Reef; ♂, Pelican Is, Great Barrier Reef, NEQ.
- Prostheclina pallida* ♀, syntype, Sydney, NSW (BMNH), epigynum, lateral carapace. ♀, ♂, Kroombit Tops, SQ, other drawings.
- 'Salpesia' squalida* ♀, Salvator Rosa National Park, SQ; ♂ palp copied from Koch & Keyserling (1871-1883).
- Sandalodes bipenicillatus* ♂, syntype, Sydney, NSW (ZMH), ♂ palp; ♀, Kroombit Tops, SQ; ♂, Rochedale, Brisbane, SEQ, other drawings.
- 'Trite' daemelii* ♀ ♂, Brookfield, Brisbane, SEQ.
- 'Trite' longula* ♀, Yule Pt, NEQ; ♂ Mt Molloy Rd, NQ. ♂ holotype of *Marptusa longula*, Somerset, NQ (MCG) examined and sketches made (VTD) in 1977.
- Zenodorus durvillei* ♀, Shipton's Flat, NQ; ♂, Lockerbie, Cape York, NQ.
- Zenodorus metallescens* ♀ ♂, Clifton Beach, NEQ.
- Zenodorus orbiculatus* ♀ ♂, Kroombit Tops, SQ.

OCCURRENCE OF THE PROTOZOANS, *LANKESTERELLA HYLAE* AND
HAEMOGREGARINA SP., IN THE BLOOD OF THE GREEN TREE FROG,
LITORIA CAERULEA

B.L.J. DELVINQUIER

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Of 62 green tree frogs, *Litoria caerulea*, collected in Queensland, 20 (32.25%) were found infected with sporozoites of *Lankesterella hylae* in their blood and a further 2 (3%) had gametocytes of *Haemogregarina* sp. A single specimen from the Darwin district, Northern Territory, was negative for both parasites. A total of 594 specimens of 60 species of native anurans and 267 specimens of the introduced cane toad, *Bufo marinus*, proved negative for intraerythrocytic protozoans. It is suggested that there is a strict host specificity for these haemoproteozoans.

□ *Lankesterella hylae*, *Haemogregarina* sp., *Litoria caerulea*, haemoproteozoans, Hylidae, Australia.

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Lankesterella hylae is the only intraerythrocytic protozoan described from Australian anurans. Cleland and Johnston (1910) described it from the red blood cells of three out of five *Litoria caerulea* from Sydney. They reported the parasite was 9-11 by 1.6-3 μ m, crescentic with a band-like and reticular nucleus, which is often nearer one end than the other, and with a bulge containing a vacuole near the middle of the body. The parasite took various positions in the erythrocyte but did not distort or enlarge it, although the nucleus of the red blood cell was more or less displaced. They also noted double and triple infections and that the crescentic appearance was lost in free forms. The organism was again recorded in one out of three *L. caerulea* from Eidsvold, Queensland, by Cleland (1914) and from Brisbane as 'very common' by Johnston (1916). Mackerras and Mackerras (1961) found it in one out of ten specimens from Brisbane and six out of thirteen from Sydney. They reported measurements of 9-11 by 2-3 μ m for the most abundant forms and 6-8 by 2 μ m for the small forms. They observed numerous free parasites in organ smears from the heavily infected frogs, and exoerythrocytic stages in the liver and spleen. These forms occurred in small macrophages and they 'were oval crescentic, or sausage-shaped, with band-like reticular nuclei, and with 1 or 2 vacuoles'. Stehbens (1966a) found it in the erythrocytes of twelve out of thirteen *L. caerulea* from Gin-Gin, Queensland. The sporozoites (7-11 by 1-3 μ m) were slender but in a number, one end was slightly less blunt than the

other, the nucleus was usually near the centre of the parasite and sometimes nearer the blunt end. At each end of the nucleus, he observed colourless vacuoles. On the concave surface of the intraerythrocytic forms he often noticed a 'dome-like swelling at or near the level of the nucleus' but could not determine its nature. He also made some observations from wet blood smears and on liver and spleen smears. The ultrastructure of *L. hylae* was studied by Stehbens (1966b).

In contrast, numerous haemoproteozoans have been reported from *Bufo marinus*. This species of toad is of South American origin and was introduced into Queensland from Hawaii in 1935 in the hope that it would eradicate two species of devastating cane beetles (Mungomery, 1935, 1936). It is now widespread (Covacevich and Archer, 1975; Freeland, 1987). Hamerton (1932) reported *Lankesterella* associated with microfilaria in the blood of captive *Bufo marinus* in the collection of the Zoological Society of London. In 1934, he reported *Lankesterella* as a single infection and *Lankesterella* associated with 'Haemogregarines' in the blood of the same species. In South America, several species of *Haemogregarina* have been described in *Bufo marinus*. A complete list of the records for this toad is given in Table 1. However, none of the reported haemoproteozoans have been detected in Australia.

There is no record of the genus *Haemogregarina* in Australian anurans, but, in New Guinea, Ewers (1968) recorded 'hemogregarines' (= *Haemogregarina* Danilewsky, 1885, and *Hepatozoon*

Miller, 1908) in 13 out of 20 *Litoria infrafronata*, 7 out of 46 *Platymantis papuensis* and 6 out of 21 *Rana papuensis*. However, Walton (1964) did not include species of the genus *Hepatozoon* in his host-parasite list and, according to Manwell (1977) *Hepatozoon* occurs in mammals, birds and 'a number of cold-blooded vertebrates'.

MATERIALS AND METHODS

Frogs and toads were captured by hand at night using a spot light. Collections were made in 99 localities in all six States of mainland Australia between 1983 and 1985. Exact descriptions of the localities with longitude, latitude, and Grid Map Index, are in Delvinquier (1987). Within two to

TABLE 1. Intraerythrocytic protozoans reported in *Bufo marinus* in South America.

PARASITE	LOCALITY	AUTHORITY
<i>Haemogregarina aguai</i> Phisalix, 1930	Brazil	Phisalix 1930 ¹
<i>Haemogregarina bufomarinus</i> Niño, 1926	Argentina	Niño 1926
<i>Haemogregarina cayennensis</i> Léger, 1918	Guiana Brazil	Léger 1918a Phisalix 1930
<i>Haemogregarina darlingi</i> Léger, 1918	Guiana Brazil Venezuela Venezuela	Léger 1918b Phisalix 1930 Scorza <i>et al.</i> 1956 see Díaz-Ungría 1960
<i>Haemogregarina legeri</i> Scorza, Dagert and Arocha, 1956	Venezuela Venezuela	Scorza <i>et al.</i> 1956 see Díaz-Ungría 1960
<i>Haemogregarina</i> spp.	Panama (U.K.) ? Guiana (U.K.) Brazil Peru	Darling 1912 ² Plimmer 1912a, 1912b Franca 1911 ³ Léger 1918b Hamerton 1933, 1934 de Figueiredo and Simões Barbosa 1943 Nickerson and Ayala 1982
<i>Lankesterella</i> sp.	(U.K.)	Hamerton 1932, 1934
<i>Karyolysus aguai</i> Scorza, Dagert and Arocha, 1956	Venezuela Venezuela	Scorza <i>et al.</i> 1956 see Díaz-Ungría 1960
<i>Schellackia balli</i> Le Bail and Landau, 1974	Guiana	Le Bail and Landau 1974
<i>Dactylosoma ranarum</i> (Kruse, 1890)	Costa Rica	Ruiz 1959
<i>Dactylosoma</i> sp.	Guiana	Le Bail and Landau 1974
<i>Cytamoeba bacterifera</i> Labbé, 1894	Peru	Lehmann 1966

1 Scorza *et al.* (1956) believed this was *Karyolysus aguai* [sic] because of 'its agamic cycle is carried through in endothelial cells'. See also entry for *Karyolysus aguai*.

2 Léger (1918b) reobserved it in *B. marinus* in Guiana and renamed it *Haemogregarina darlingi*.

3 According to Walton (1964), but he may have been misquoting the author or the date because I could not find the reference in *Zoological Record* or 'The Index-Catalogue of Medical and Veterinary Zoology'.

three days of their capture, each specimen was dissected after being anaesthetized with chloroform. Thin blood smears were fixed with methanol and stained with Giemsa 10% in sodium-potassium phosphate buffer at pH 7.0. In all, 924 specimens of 62 species in 5 families of anurans were examined for the presence of intraerythrocytic protozoans.

The numbers of frogs and toads dissected are as follows [nomenclature follows Cogger *et al.* (1983) and Czechura *et al.* (1987)]: BUFONIDAE: *Bufo marinus*, 267; HYLIDAE: *Cyclorana brevipes*, 1; *C. novaehollandiae*, 6; *Litoria alboguttata*, 1; *L. caerulea*, 63; *L. chloris*, 14; *L. cyclorhyncha*, 5; *L. dahlii*, 10; *L. dentata*, 5; *L. ewingii*, 3; *L. fallax*, 72; *L. gracilentata*, 5; *L. inermis*, 26; *L. infrafrenata*, 1; *L. latopalmata*, 20; *L. lesueuri*, 28; *L. moorei*, 1; *L. nannotis*, 2; *L. nasuta*, 36; *L. nigrofrenata*, 1; *L. nyakalensis*, 5; *L. pallida*, 21; *L. pearsoniana*, 3; *L. peronii*, 26; *L. raniformis*, 1; *L. revelata*, 2; *L. rheocola*, 11; *L. rothli*, 32; *L. rubella*, 26; *L. serrata*, 2; *L. tornieri*, 15; *L. tyleri*, 2; *L. verreauxii*, 1; *Nyctimystes dayi*, 10; MYOBATRACHIDAE: *Adelotus brevis*, 3; *Assa darlingtoni*, 4; *Limnodynastes convexiusculus*, 2; *L. dorsalis*, 3; *L. dumerilii*, 4; *L. ornatus*, 10; *L. peronii*, 21; *L. salmini*, 2; *L. tasmaniensis*, 13; *L. terraereginae*, 14; *Mixophyes fasciolatus*, 6; *M. iteratus*, 2; *M. schevilli*, 3; *Neobatrachus centralis*, 2; *N. pelobatoides*, 3; *N. pictus*, 4; *Pseudophryne bibronii*, 1; *P. coriacea*, 2; *Ranidella bilingua*, 9; *R. insignifera*, 1; *R. parinsignifera*, 20; *R. signifera*, 39; *Taudactylus aculirostris*, 3; *T. rheophilus*, 2; *Uperoleia laevigata*, 4; MICROHYLIDAE: *Cophixalus ornatus*, 6; *Sphenophryne robusta*, 2; RANIDAE: *Rana daemeli*, 4.

Measurements are followed in brackets by the standard deviation of the sample (SDS), and number of specimens measured (N).

RESULTS

Lankesterella hylae and *Haemogregarina* sp. were the only intraerythrocytic protozoans that I found in Australian anurans. Both occurred in the red blood cells of *Litoria caerulea*. None of the other intraerythrocytic protozoans, *Dactylosoma ranarum* (Kruse, 1890) and *Cytamoeba bacterifera* (Labbé, 1894) were found.

Lankesterella hylae (Cleland and Johnston, 1910)
(Figs 1,2,3)

MATERIAL EXAMINED

Commonwealth Institute of Health, University of

Sydney: *Lankesterella hylae* - *Litoria caerulea*, Sydney, 1909-10, 3 slides, Cleland and Johnston's collection [well stained specimens]; *Lankesterella hylae* - *Litoria caerulea*, 2 slides (well stained specimens on one slide; the other slide is labelled a 'scanty infection' but I did not find any specimens); *Lankesterella hylae* - *Litoria caerulea*, 2 slides, Mackerras and Mackerras's collection [well stained specimens]. Queensland Museum GL4863; United States National Museum 38856; British Museum (Natural History) 1987.1.19.1; Museum of Comparative Zoology (Harvard University) 8; all from *Litoria caerulea*, Kingaroy (151°51'E, 26°37'S; Grid Map Index: LR857550 9244-1), Queensland, April 1983.

DESCRIPTION

This protozoan was only observed in the erythrocytes of the common green tree frog, *Litoria caerulea*, in the localities listed in Table 2. Figure 1 gives the geographical distribution of *Litoria caerulea* based on Cogger (1983) with geographical records of the protozoan.

The sporozoite is a slender, crescentic form which measures on average (intracorporeal form) 8.9 (SDS±1.7) by 2.0 µm (SDS±0.7) (N=33) (range: 5.8 to 14.6 by 0.7 to 3.6 µm). The cytoplasm is pale blue when stained with Giemsa and contains in the middle an oval vacuole surrounded by masses of chromatin. This vacuole can be large enough to deform the shape of the sporozoite and create a bulge in its outline. The band-like nucleus is situated near one end of the parasite (see Figs 2,3). I did not find it in the leucocytes.

Infections were scanty, with a mean of only 2.3% erythrocytes infected (N=4000 cells counted



FIG. 1. Geographical distribution of *Litoria caerulea* (stippled area) according to Cogger (1983) and records of *Lankesterella hylae* and *Haemogregarina* sp. Numbers refer to districts as in Table 2.

in smears stained with Giemsa). In the museum material, I found 2.0% erythrocytes infected in the three slides of Cleland and Johnston (N=300), 1.7% in the well stained slide made by the anonymous collector (N=100), and 6.6% in the two slides of Mackerras and Mackerras. Multiple infections, two sporozoites in one erythrocyte, were occasionally observed (see Fig. 3). A few free sporozoites were also seen. Erythrocytes were never deformed by the presence of the protozoan but the nucleus was slightly displaced.

COMMENTS

The form I observed in the erythrocytes of *Litoria caerulea* closely agrees with the description of the previous workers (Cleland and Johnston, 1910; Mackerras and Mackerras, 1961; Stehbens, 1966a).

Haemogregarina sp. of *Litoria caerulea* (Figs 1,4,5)

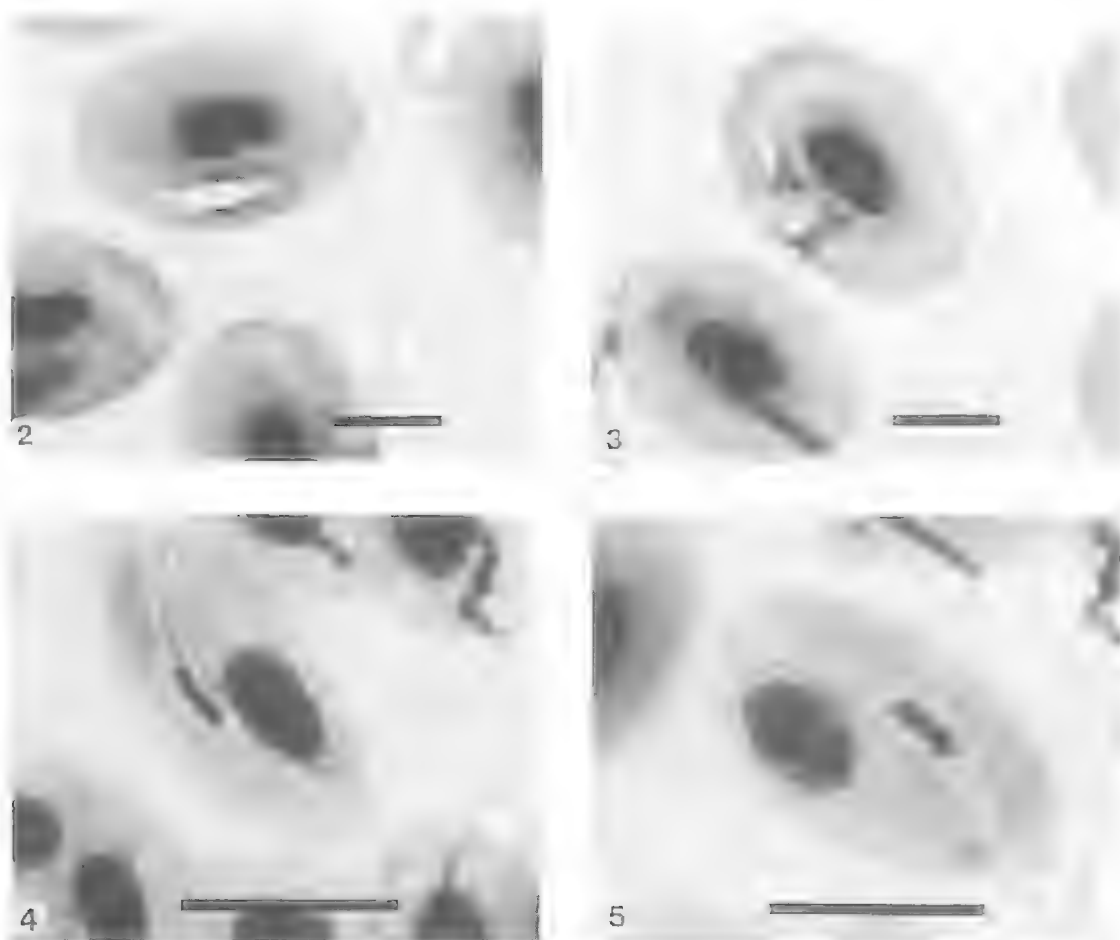
MATERIAL EXAMINED

Queensland Museum GL4864: *Litoria caerulea*, Bushy Creek, (145° 20'E, 16°36'S; Grid Map Index: CB223627 7964), Queensland, November 1983.

DESCRIPTION

I have observed this protozoan in only two specimens of *Litoria caerulea* from Bushy Creek, North Queensland (see Table 2). None of the 267 adult specimens of *Bufo marinus* were infected.

It has a narrow elongated body with rounded extremities. It is slightly bent around the nucleus of the erythrocyte. It measures on average 19.4



FIGS 2-5. 2: Single infection of *Lankesterella hylae* in an erythrocyte of *Litoria caerulea* from Kingaroy. Scale bar: 10 μ m. 3: Double infection of *Lankesterella hylae* in an erythrocyte of *Litoria caerulea* from Kingaroy. Scale bar: 10 μ m. 4-5: *Haemogregarina* sp. in an erythrocyte of *Litoria caerulea* from Bushy Creek. Scale bar: 20 μ m.

(SDS = 2.2) by $2.0\ \mu\text{m}$ (SDS = 0.4) (N = 23) (range: 16.0 to 23.3 by 1.5 to $2.9\ \mu\text{m}$). The nucleus is situated in about the middle of the cell (see Figs 4 and 5). No bulge was observed. It typically deforms the erythrocyte it invades by elongating it. Only single infections were found in the erythrocytes. I observed the parasite in an average of 3% of the host erythrocytes (N = 100).

COMMENTS

I consider the form that I observed to be the gametocyte stage of a species of *Haemogregarina*. It has the features typical of the gametocytes of other species of that genus: intraerythrocytic, elongated, slender with rounded extremities, nucleus situated in the middle or near the narrower extremity.

TABLE 2. Occurrence and geographical distribution of *Lankesterella hylae* and *Haemogregarina* sp. in *Litoria caerulea*.

Localities	Collection dates	Number collected	Number infected
QUEENSLAND			
1. Brisbane district			
St Lucia	Mar. 1983	1	0
	Apr. 1983	1	0
	Sep. 1983	2	0
Chapel Hill	Mar. 1983	1	0
2. Kingaroy district			
Kingaroy	Apr. 1983	11	8
Kumbia	Jan. 1984	2	2
Wooroolin	Jan. 1984	2	0
3. Gympie district			
Gunalda	Apr. 1983	5	5
4. Gayndah district			
Barambah Creek	Jan. 1984	2	0
Gayndah	Jan. 1984	1	0
Gayndah-Eidsvold Road	Jan. 1984	5	2
5. Bundaberg district			
Bundaberg	Jul. 1983	11	0
6. Rockhampton district			
Yeppoon	Aug. 1983	4	0
7. Mackay district			
Eungella-Mackay Road	Nov. 1983	1	0
Marian	Nov. 1983	1	1
8. Townsville district			
Townsville	Nov. 1983	4	0
9. Atherton district			
Emerald Creek	Nov. 1983	2	1
Mareeba	Dec. 1984	1	1
Bushy Creek	Nov. 1983	4	2*
Herberton	Dec. 1984	1	0
NORTHERN TERRITORY			
1. Darwin district			
Wildman River	Jun. 1985	1	0

* *Haemogregarina* sp.

DISCUSSION

From my observations, as well as those of the previous workers, (Cleland and Johnston, 1910; Cleland, 1914; Johnston, 1916; Mackerras and Mackerras, 1961; Stehbens, 1966a). *Lankesterella hylae* occurs only in *Litoria caerulea*. Furthermore, this species of frog is so far the only Australian anuran to be found infected with a species of *Haemogregarina*. The absence of *Lankesterella* and of *Haemogregarina* in *Bufo marinus* is probably explained by a lack of infected specimens among the original stock (101 toads, see Mungomery, 1935), or to the absence of a suitable vector.

The highly restricted occurrence of *Lankesterella* and of *Haemogregarina* in Australian anurans calls for remark. Cleland and Johnston (1910), having noticed the common occurrence of *Lankesterella hylae* in the green tree frog *Litoria caerulea* and its absence in the blood of *Litoria aurea*, suggested that either the parasite was host specific, or that the intermediate host could not have access to *L. aurea* due to differences in the living habits of the two frog species. However, they regarded the latter hypothesis as unlikely. They also suggested that a leech was the intermediate host. Stehbens (1966a) thought that an insect such as a mosquito acted as the intermediate host. He had discovered intracellular parasites in the small intestine of the frog, within unidentified cells that he regarded as probably macrophages, or possibly enlarged and proliferated endothelial cells. He suggested that infection took place with ingestion by the green tree frog of an infected mosquito. The sporozoites released by the mosquito would enter the intestinal wall of the frog and develop into schizonts. Farmer (1980) considered that leeches were unlikely because 'the hosts are tree frogs' and instead suggested blood-sucking insects. On the other hand, Nöller (1913, 1920) demonstrated that a leech, *Hemiclepsis marginata*, passively transmits *Lankesterella minima* to *Rana esculenta* when the frog eats the leech. There is no evidence that a blood-sucking insect rather than a leech is the intermediate host in the life cycle of *L. hylae*.

L. caerulea has arboreal habits and is often found near houses where it is able to find water (for example in toilets and water tanks). I rarely found it near ponds, and when I did, it was after a warm rain shower at night during the breeding season. Other related arboreal species, such as the very common *Litoria fallax*, *L. peronii*, *L. rubella*, are sometimes found near houses in the same conditions. The former two species are also very

common in ponds and are calling most nights in summer whereas the green tree frog usually calls only after a warm shower. *L. rubella* was often found sitting, as was *L. caerulea*, on the road at night. From my own observations of the habits of species closely related to *L. caerulea*, I do not think that living habits of the green tree frog differ from these frogs in a way sufficient to explain the absence of the genus *Lankesterella* from other Australian anurans. I am therefore inclined to follow the first suggestion of Cleland and Johnston (1910) and believe that specificity of *L. hylae* is determined, but in an unknown way, by its ability to develop only in *L. caerulea*.

In the case of the genus *Haemogregarina*, the infection begins when an invertebrate blood-sucking vector bites the vertebrate host (Reichenow, 1910). Despite this difference, *Haemogregarina* sp. appears to be like *Lankesterella hylae* in being restricted to *L. caerulea*. I suggest that the specificity of *Haemogregarina* is determined in the same way as in *Lankesterella*.

The finding of 'hemogregarines' in *Litoria infrafronata* from New Guinea by Ewers (1968) is interesting. *L. infrafronata* is an hylid also found in North Queensland 'in and around the remnants of rainforest on the eastern coastline of the Cape York' (Tyler, 1976) and by its size and shape resembles very much *Litoria caerulea*. It may be that the Australian species also harbours some haemogregarines but I only captured one specimen of *L. infrafronata* and it was negative. He also found 'hemogregarines' in the blood of two ranids, *Rana papuensis* and *Platymanthis papuensis*. In Australia, there is only one ranid, *Rana daemeli* and the four specimens I collected were also negative. Records of the genera *Lankesterella* and *Haemogregarina* are mainly in ranids and in bufonids (see Walton, 1964).

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ETOLO TRAPS: TECHNIQUES AND CLASSIFICATION

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Trapping wild animals to eat is a major technological mode among Etolo people, Southern Highlands Province, Papua New Guinea. Deadfall traps, drop-log tree traps and spring snares used to capture mammals and cassowaries are illustrated and described with reference to their structure, targetted species and the locations where they are built. The classification of different trap types by Etolo is briefly summarized.

□ *Papua New Guinea, Etolo, ethnoclassification, hunting, trapping, mammals.*

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Ethnographic literature from Papua New Guinea includes many references to traps and trapping (e.g. reviews of Anell, 1960; and Bulmer, 1968, 1972; also Barth, 1975; Clarke, 1971; Cranstone, 1972; Herdt, 1981; Kelly, 1977; Pospisil, 1963; Rappaport, 1968; Williams, 1940). Most are incidental reports. A detailed account of trapping techniques is not available from any Papua New Guinean society. Nearly all reports are placed within and, indeed, indexed under a broad category of hunting. In this they understate both the importance of trapping in some societies and the contrasting technologies that underlie trapping and hunting respectively.

This paper attempts to fill a gap. By describing traps and their classification in one society it encourages recognition of trapping as a major technological mode. The people are Etolo. They live on forest-clad mountain slopes rising from the northern edge of the Great Papuan Plateau, Southern Highlands Province. For them and their Onabasulu and Kaluli neighbours on the Plateau trapping mammals provided a useful contribution to diet (Ernst, 1984; Kelly, 1977; Schieffelin, 1975).

During 15 months in 1979-80 I lived with Etolo people at the village of Bobole (population 109, altitude 1100 metres). Through a 52 week period, game mammals (i.e. mammal species greater than 250 gm) contributed an average of 6 grams protein (i.e. 36.2 grams edible portion) per person per day. This was slightly more than half the protein people obtained from animal sources. Of more importance, game mammals provided the most regular input of animal protein. During 13 four-week periods the average daily quota of protein from game mammals was between four and nine grams per person (Dwyer, 1985). Mammals that had been trapped comprised between 36 and 40 percent of a total of 1802 game mammals; they contributed

approximately 35 percent of the protein obtained from this source.

The Etolo built several different sorts of traps; deadfalls on the ground, tree traps and spring snares. (The term *sumiti* was used to specify capture of an animal by trapping). These different types were designed to obtain different game. Deadfalls took many bandicoots (species of *Peroryctes* and *Echymipera*) and wallabies (*Dorcopus vanheurni*); tree traps took many Stein's cuscus (*Phalanger interpositus*) and most snares were built to capture dwarf cassowaries (*Casuarius bennetti*). (The people did not use traps to capture small birds). Of 34 species of game mammal taken in a 12 month period 26 were obtained in traps. Trapping produced more than 50% of the captures of 10 species and was the most important technique of capture of three other species. Further details of the mammalian species captured and of the seasonality of trapping appear in other papers (Dwyer, 1982a, b; see also Dwyer, 1983; and Kelly, 1977, for accounts of Etolo hunting and subsistence practices respectively). Here I describe the traps themselves and their classification by Etolo; collectively they were named *sane*.

DEADFALL TRAPS

A short avenue of stakes lying either side of a longer drop log comprised the gross structure of a deadfall trap (Fig. 1). At the 'head' end (*pusa mea*) the log projected only a short way beyond the avenue, at the 'tail' end (*hope mea*) it projected some distance. At the head end the line of stakes on one side of the avenue terminated with a forked stick; this was taller than other stakes and sloped inwards across the open space of the avenue. In appearance the structure was a miniature gloomy forest, as indicated by the Etolo name of *itiliba* —

the forest way — for the fatal pathway running between the stakes. Indeed, with abandoned deadfalls the effect might be enhanced because disuse transformed many stakes into regenerating leafy saplings.

A stout branch, the hoist rod, perhaps a metre long, rested within the arms of the forked stick; a short, robust, loop of vine around this lifted the head of the drop log 60 to 80 centimetres above the ground. The log sloped gently downwards through the avenue, pivoted on its tail. A second loop, longer and of delicate construction, encircled the hoist rod towards the rear. This was pulled downwards. Its free end passed outside the avenue of stakes, always on the same side as the fork, and inside and beneath the apex of an arched limb whose ends were thrust immovably into the ground. The arch ran parallel to the stakes about 10 centimetres from them. Here the loop passed around the tip of a short, vertical, toggle holding it firmly against the outside rim of the arch. The free end of this toggle was being tugged towards the avenue but its movement was prevented by the critical trigger stick; a slender rod held in place at one end by the lower part of the toggle and at the other end by the far wall of the avenue. Thus the trigger stick passed through a small gap between two stakes on the side of the avenue near the arch, crossed the avenue a few centimetres above the ground, and rested against the smooth face of an upright stake on the other side. It had to be able to drop freely. The deadfall trap was now set. The intended victim need only dislodge the trigger stick to seal its fate. The toggle was freed, catapulting the hoist rod forwards and dropping the hefty log to pretenderize as it killed the unfortunate beast. The catch could be retrieved at leisure and the fallen log once more poised above the 'forest way'. The design of these traps was similar to that reported by Margaret Mead for the Arapesh (Ansell, 1960, fig. 25, pp 95–96). The Arapesh trap lacked a toggle; the loop from the hoist rod connected directly to the trigger stick holding it firmly against the apex of the hoop. Without a toggle the trap would be less sensitive.

There were numerous variations of this type of trap. Some were idiosyncrasies. Other concerned the size of the intended quarry or were adaptations fitting the trap to particular circumstances of, for example, terrain or species. Deadfalls might be built either as singles or in series with a low fence running between the individual traps. If as singles, then the quarry was enticed into the trap by offering bait; if in series then bait was unnecessary because the interconnecting fence channelled prey

to the desired position. Different baits were used. A portion of sweet potato fixed to the end of the trigger stick, within the avenue, would suffice. Though, with such inferior bait, it was best to chew additional sweet potato into mush and spit this along the avenue and near the entrance as attractant. Live baits were more highly regarded; grasshoppers or wood-boring grubs wrapped in neat leaf packages and tied to the trigger. Or, for forest wallabies, the fruit of wild gingers was satisfactory.

The form of the avenue within which the drop log floated was variable. Some people preferred a tall avenue of vertical stakes while others built quite low avenues, perhaps 40 centimetres, with the stakes sloping outwards at a reckless angle. In some traps the two rows of stakes formed all but solid walls and in others the avenue looked careless with numerous gaps. To my knowledge these differences did not affect the catch. The art was in positioning the trigger stick so it would not jam and in stringing the hoist rod for a finely tuned drop log. In some traps the drop log was on rough ground and levelling poles, or backstops to prevent slip, were used (Fig. 1). Again, if the weight of the log was judged insufficient one or more extra limbs would be laid across it, obliquely or at right angles, towards the rear end. Added weight in this position could be exploited in the sometimes tricky business of steadying the drop log precisely above the floor of the avenue. In one further variant the wall of a garden house formed one side of the avenue and the trap was intended to eliminate a minor plague of thieving rats.

Deadfall traps came in many sizes. The smallest were toys and not intended as anything else. Children made them in idle moments, perhaps in a garden while their parents were weeding. Beside hunting shelters in the forest small children, aided by their parents or an older brother, built larger though still insubstantial models; a drop log a metre long, 10 centimetres thick, could kill a small forest rat. Scattered through gardens, in regrowth near houses or near campsites in the forest were recent and rotted deadfalls whose purpose was or had been more serious. In these the drop log was two metres long and 15 centimetres thick. It could flatten a little rat and kill bandicoots or the smaller of the giant rats. The irritation of discovering damaged garden crops, the excitement of finding a runway or tell-tale footprints in the forest, were stimuli to build these deadfalls. They were modestly named *ebele sane*, where *ebele* were small mammals, but the unspoken desire was for larger game.

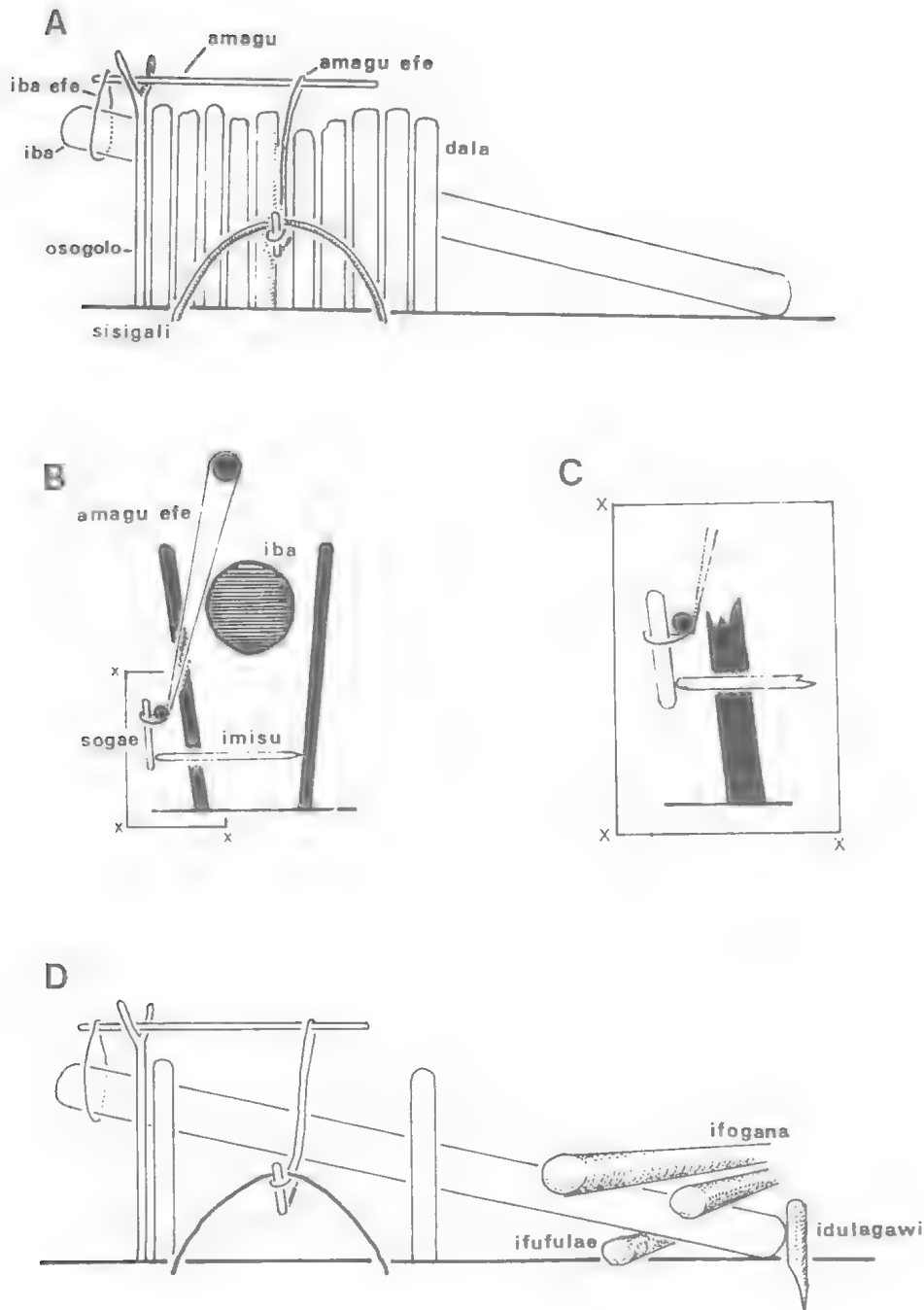


FIG. 1. Deadfall trap. A — plan from side. B — cross-section, enlarged, to show mechanism. C — detail of toggle and trigger stick. D — plan showing ancillary weights, levellers and props. Etolo names for parts are shown on the diagrams. The names are listed hereafter together with their etymology, where known to me, and English equivalents. *Dala* (= fence), avenue; *osogolo* (= forking), forked stick; *sisigali* (= bending into an arch or hoop), arch; *iba* (*i* = tree or log, *iba* not known), drop log; *iba efe* (*efe* = rope), support loop for drop log; *amagu*, hoist rod; *amagu efe*, loop from hoist rod to toggle; *sogae*, toggle; *imisu*, trigger stick. Logs or limbs used to provide added weight and as levellers or props are named, respectively, as *ifogani*, *ifufulae* and *idulagawi* in Etolo; these terms are probably directly descriptive of function.

In the vicinity of Bobole I located 45 deadfall traps that would qualify as *ebele sane*. Nineteen were in gardens, one in a pandanus orchard, 12 in regrowth forest close to the village and 13 in primary forest. Fifteen of these, three in gardens, seven in regrowth and five in forest, were old and rotting; the remainder were functional though not all in use when I saw them. In one garden there were five, all operating. Of those in the forest six were very close to shelters and seven a short walk away. These latter were spread over 150 metres in a moderately level area of mud soaks and seepages that was crisscrossed by footprints of rats and bandicoots. Two of these traps were functional when found. The others were in varying stages of decay.

Oheo were game mammals and *oheo sane* were designed to take them. These deadfalls were robust in build and thoughtfully placed. The drop log was about three metres long, up to 20 centimetres thick. It might be weighted with ancillary limbs. The immediate environs were often garnished with distractors encouraging the quarry to follow one path. Most of these large deadfalls occurred as series set into drift fences. I saw five that were singletons. One was an ancient, collapsed, deadfall positioned near the edge of a low cliff where an animal climbing the cliff would be likely to reach the top. In better days a short fence had run from either side of the avenue to the cliff edge, embracing the full span of possible routes. The second singleton was on a narrow ridge where a track led to a garden; it was placed centrally within 10 metres of fence running from the edge of a cliff to a large log. An animal travelling down the ridge or close to the log would be led into the entrance of the trap. The remaining three traps were designed for terrestrial cuscus (*Phalanger gymnotis*). They were in regrowth or forest and, at first glance, seemed to be cumbersome, bulky, boxes. They were rugged deadfalls entirely encased in a frame. Even at ground level the earth had been scraped from the floor of the avenue and replaced by a roughly hewn plank. Each of these traps was built with the head of the drop log floating directly over the entrance to an underground lair of a cuscus. The quarry had two undesirable choices; either it remained in its lair and starved or it emerged and triggered the trap. When the catch had been made the trap was temporarily altered. The drop log was raised and fixed in position and an opening broken into one side of the frame near the head end. A limb passed from this opening to low branches or the trunk of a nearby tree and for a period the trap became a lure. A replacement

cuscus was 'invited' to take up residence in the now vacant den. When fresh claw marks, droppings, or a familiar smell advertised its presence the frame was closed and the trap reset. I was told one of these traps produced three captures in less than a year.

Series of traps could be either small or large scale ventures. The former were temporary, built at the time new gardens were established and placed within easy access of the path to the garden. They would be operated during a few months in one year and then abandoned. I found two of these; a group of two traps in a six metre fence and a series of five in a 40 metre fence. The shorter set adjoined a stream below a steep gully and the fence ran from the base of a cliff to a thicket in boulders. One third of the fence for the series of five was a log that ran up hill from a stream. One trap was positioned to take animals that passed beneath the log. The rest of the fence and the remaining traps continued up hill beyond the log. Large scale systems were the focus of trapping. They could include more than 40 deadfalls in fences several hundred metres long. They were situated in advanced regrowth or primary forest and were repaired and reused on an annual basis. Fifteen were operated in 1979, one in a desultory fashion, and all but the last had operated at least the previous year. A portion of a sixteenth series, a light weight design built a few years earlier by two youthful brothers, was operated by another family during a few months in 1979 when they prepared a garden nearby. This series was in regrowth, 15 to 20 years old; the fence crossed fairly level land between two streams, a distance of about 60 metres and sufficient at the most for 15 deadfalls. When I saw it only four traps were functional. A new garden had destroyed the remainder.

I saw four of the large series of deadfalls that operated in 1979 and found a fifth, old and collapsed, system. One was in 20 years old regrowth at an altitude of about 1000 metres, two in advanced regrowth abutting primary forest at 1200 metres and two, including the decayed system, in primary forest at about 1400 metres. Information received suggested that all but two of the remaining 11 were in primary forest; one was below the altitude of Bobole, the rest at higher elevations. Two of the five systems examined by me consisted of a long series of traps in a single fence together with one or two ancillary sets nearby. Thus one series, in regrowth, included 18 deadfalls in a fence 109 metres long that crossed a low ridge between two streams. Associated with these, but across and downstream from them, were three

more traps in 20 metres of fence that connected a steep drop into the stream with a log. The second of these systems included 36 traps in a fence about 200 to 250 metres long. The fence crossed a ridge from a steep gravel and mud slip on one side to a steep embankment on the other. Several hundred metres away were two groups, each of four traps, in fences 25 metres long. These fences blocked off narrow ridges between steep embankments. One set of four was new in 1979. A third system of 23 traps in 139 metres of fence ran from the edge of a mountain torrent across a gentle incline where, for 30 metres, it was close to a young pandanus orchard. Then it turned steeply up hill to terminate at an embankment. The fourth of the operating systems was the most spectacular. It was in forest and included 36 traps — two were new in 1979 — in 300 to 350 metres of fence. The country traversed was very steep, broken by minor cliffs and crossed by occasional gullies and streams. The fence line twisted and turned up the slope, incorporating fallen logs and cliffs into the structure, until it ended abruptly at a rock face plunging to the headwaters of a torrent. For about 100 metres of the total length there had been no need to build any fence. The collapsed system, overgrown and covered by thickets, had included at least 32 traps in a fence of approximately 250 metres. It ran from the crest of a ridge, down a moderately gentle slope and across a flat to the end of a log. I was told that one other system, which I did not see, included 37 traps. Thus, in six systems, the average number of traps was 32 and in five, the average length of effective fence, though not necessarily of built fence, was approximately 225 metres. At Bobole, people were probably operating nearly 500 deadfall traps in more than three kilometres of fence. Clearly, they were intent upon harvesting available game.

Each of these large systems of traps effectively blocked off routes that animals would regularly traverse. The design of the fence enhanced the chance that an animal would run along it. Fences were irregular in height, usually between 70 and 100 centimetres. They might be of stakes thrust into the ground and tied, at the top, to long horizontal poles fastened between trees. These poles might be separately propped. Or the fence could be more flimsy, consisting of sheets of bark resting against the supporting frame. Along most of their length all fences were inclined as much as 30 degrees from the vertical. The direction of slope switched erratically along the length of the fence but was always aligned with the head end of each trap. An animal running beneath the overhang of

the fence passed the gaps that led down the avenues of stakes.

In the two drift-fence systems crossing relatively level regrowth areas trap spacing was fairly regular; in the 18 trap series the traps were from three to 9.5 metres apart (mean 5.8 metres) and in the 23 traps series they were from 2.5 to 12.5 metres apart (mean 5.9 metres). In rough country some traps might be 20 to 30 metres apart. These longer distances occurred at cliff edges or where logs, lying flush with the ground, were part of the fence. Trap design varied both between systems and in accommodation to landscape features. In one system nearly all the drop logs were very heavy, yet the avenues were remarkably flimsy. In the other three systems the drop logs were lighter but were often reinforced by additional limbs placed on top along their length and were weighted by other limbs placed obliquely or transversely. The avenues of these latter systems were of robust construction. Traps were often sited with deliberate reference to natural features. Possible runways beside, between or beneath logs were regularly used or, again, traps were built at places where an animal might scramble across an embankment or small cliff. Some traps were perpendicular to the fence; nearly all of them in one system. Many were angled to the fence and a few were parallel, such that the fence was stepped, taking both sides of the avenue into its structure. Some of these designs are illustrated in Figure 2.

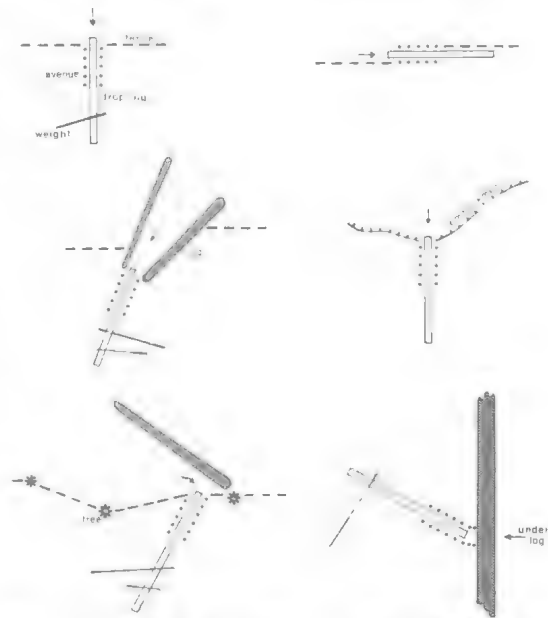


FIG. 2. Designs for the layout of some deadfall traps. Arrows show direction of entry into avenue.

Within the avenues the trigger sticks were usually set about four centimetres above the ground. They were sufficiently rigid that small rats could not dislodge them, and were usually camouflaged by dead leaves or a fern frond.

The *segeligi sane* was the *pièce de résistance* of Etolo traps. It was to trap wild pigs. The two I saw were at lower altitudes than Bobole though one belonged to people from Bobole. The design of one is sketched in Figure 3. The avenue of carefully hewn poles stood 1.67 metres high, was 2.5 metres long and two-thirds of a metre wide. The 'drop log' was of five or six logs and some smaller limbs. These were bound tightly together as a single massive structure five metres long, 25

centimetres thick, occupying the full width of the avenue. To hoist this into the air called for adaptation of the mechanism. A forked pole was present on each side at the head of the avenue. Another pole rested horizontally within the arms of these forks and the hoist rod, two metres long, pivoted centrally on this. A rope around the front of the hoist rod supported the drop log. At the rear the hoist rod was held down by another rope passing from one side of the avenue, where it was securely fastened near the base, to the other side where it connected to the trigger mechanism. A stout frame corresponded to the arch of a conventional deadfall trap. The rope passed outside this and immediately turned inwards beneath it. Here

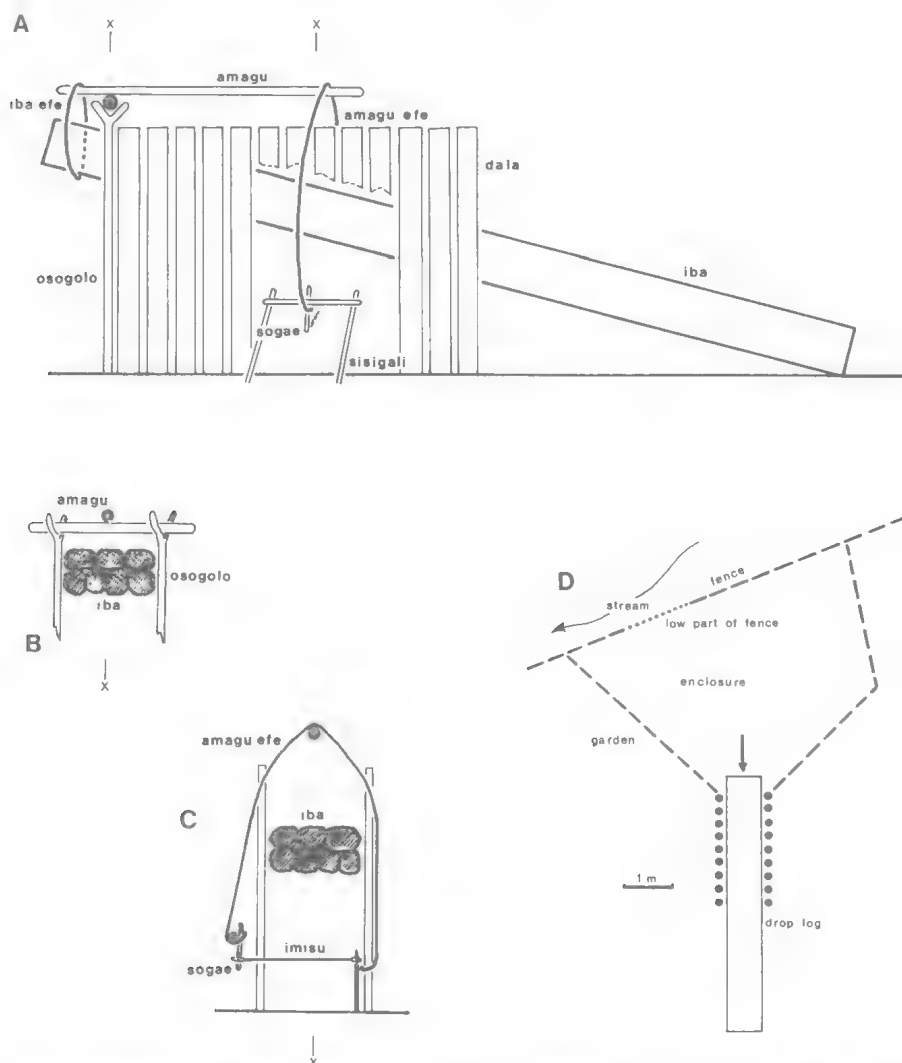


FIG. 3. A deadfall trap designed for wild pig. A — plan from side with part of the avenue removed. B and C — cross-sections. D — plan of layout for a large deadfall. Labelling is as for Figure 1.

it was fastened to a portion of limb, about 20 centimetres long and two or three centimetres thick, that it held firmly against the inside rim of the cross piece of the 'arch'. Tension on this toggle would drag its lower end outwards, away from the avenue, rather than inwards as in the standard design. This movement was prevented by the 'trigger stick' — a taut rope, nearly one centimetre in diameter, which was tied to the peg on one side, passed across the avenue, and looped over the top of a carefully prepared stake. This stake was thrust deep into the ground near the far wall of the avenue. A pig passing beneath the taut rope would lift it free from the sharpened tip of the stake to release the drop leg. In this particular trap the trigger was set so high I imagined the system to be currently inactivated. I was wrong. It was designed to take a particular pig and that pig only, a huge wild boar that ravaged the small garden into which the trap led. Kabi of Ingridisado, who owned the garden, said it did not matter if other smaller pigs sauntered happily beneath the trigger to his crops. In fact, this was an unlikely event. The pig in question had previously broken part of the garden fence where this ran beside the edge of a stream. Kabi had repaired much of the fence but had left a gap sufficient for a powerful pig to cross. If it did so it entered a newly built and strongly fenced enclosure that offered immediate escape through the deadfall trap (Fig. 3).

The second *segeligi sane* was in a sago grove and intended to protect sago grubs that were being incubated nearby. The rear end of the drop log and all the exterior mechanism were caged to prevent triggering by disturbance from outside the trap. Sago pith was scattered near the entrance and in the avenue, with a large amount at the rear where the drop log came down to the ground. To reach this bait a pig would have to worry a horizontally placed forked stick from its position. This was the trigger stick.

TREE TRAPS

The design of tree traps was more intricate than that of other Etole traps. They required greater skill and more time to manufacture. Figure 4 illustrates basic features of the mechanism (A,B) and of the elaborately woven cage that formed a shallow supporting basket (C) and walls (D) for the trap. A horizontal pole linked two trees, perhaps across a track, as an aerial roadway for an animal. Height above ground varied but was typically between two and four metres. The roadway lay within the arms of a forked pole that

was thrust into the ground and often steadied by props and a climbing frame. A rod was fastened across the arms of the fork, near their tips; on either side it projected a short distance beyond the arms. The cage, which would house the mechanism, was woven from two lengths of vine. One was for the walls (see Fig. 4D). It took the form of a series of two, three or four elongate and tightly concentric loops centered beneath the horizontal roadway and folded upwards to pass over the ends of the rod where this projected beyond the arms of the fork. The basket (or base) of the cage was woven from a single vine as a series of concentric arches that curved outwards and upwards on either side of the roadway (see Fig. 4C). These arches were tightly looped around the roadway on opposite sides of the fork. Here they were secured by a 'holdfast rod', at least as long as the cage, that was bound to the roadway, about one centimetre above it. In some tree traps the walls were made first and the basket followed; in others the two portions were interwoven. The fork was positioned centrally within the finished cage which might be 40 to 50 centimetres high, 60 to 70 centimetres long and 20 to 25 centimetres wide.

Three nooses of either cane or bamboo were positioned within the cage, about 10 centimetres apart, with slip knots lying between the holdfast rod and the roadway (see Fig. 4B). The free ends of these nooses were attached to the middle of the drop log. This was about a metre long by 1.5 centimetres thick. It was suspended to one side of the cage and a few centimetres below it. A loop of cane tied to the middle of the drop log passed above one end of the transverse rod linking the arms of the fork (see Fig. 4A). It held the tip of a moderately long toggle against the rod. The trigger stick lay across the cage above the level of the basket. It might be concealed beneath leaves and was placed so an animal moving through the nooses would step onto it. On one side of the cage, opposite the drop log, the trigger stick was connected by a light vine to the rod lying between the arms of the fork. On the other side it was placed between the toggle itself and the loop of cane that connected the toggle to the drop log. The orientation of toggle and loop were such that pressure from the former, derived ultimately through the drop log, wedged the trigger stick firmly against the loop. It could not move in the horizontal plane but was free to be moved in the vertical plane. This occurred if an animal travelling along the roadway stepped onto the trigger stick, pushing it below the level of the toggle to release the drop log and thereby close the nooses.

I located 23 tree traps that were functional or had functioned during 1979. They belonged to 10 or 11 men or families but were not the full complement of tree traps used by these people. Eight or nine other men or families also operated tree traps and I estimate that between 50 and 75 tree traps were in use during the year. Tree traps suffered from use. Before they died captured animals chewed through the vines of the cage and nooses were pulled out of alignment. The life of the trap, particularly if it was successful, might be a few months only. Two built in August had

broken down by mid-December and mid-January respectively. Certainly, none could be repaired and used in more than one year. Thirteen of the traps I saw were situated above tracks, usually in 10 to 20 year old regrowth, in the neighbourhood of gardens. Trees overhanging the track often had been slashed for 20 to 30 metres in both directions to restrict possible crossing places to the artificial roadway provided by the trap. In one trap the roadway gave access to a potential den site in a hollow stump but all others were in foraging rather than resting situations. Ten of the tree traps were

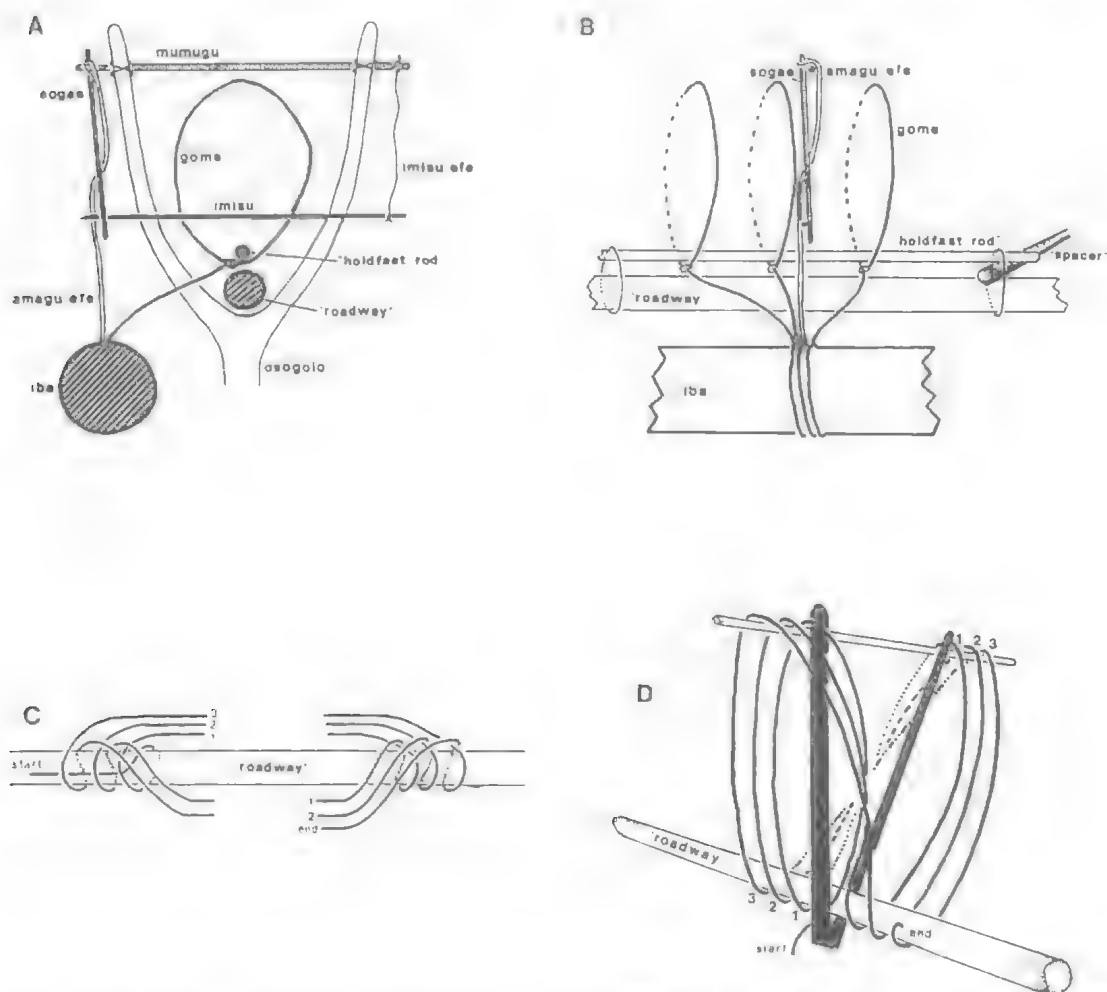


FIG. 4. Tree trap. A — cross-section through primary vertical support. B — plan from side. In A and B the rope work of the basket and walls of the cage are omitted. The designs for this rope work are shown in C and D respectively. Etolo names, where known, are shown on the diagrams. They are listed hereafter together with English equivalents. *Osogolo*, forked stick; *mumugu*, rod connecting arms of forked stick; *iba*, drop log; *amagu efe*, loop passing from drop log to 'mumugu' and held by the toggle; *sogae*, toggle; *imisu*, trigger stick; *imisu efe*, light length of vine from trigger stick to 'mumugu'; *gome*, noose. I did not learn Etolo names for the parts labelled 'runway' and 'holdfast rod'.

in forest and made use of natural runways above gullies or streams. Several were on or close to routes taken by people when they were visiting their deadfall traps. In three of these forest traps the runway — either a slender branch or vine — was built into the roadway of the trap. In four others, all on the banks of a stream, the trap was close to the trunk of a tree; a branch arching across the stream from the opposite bank was bound to the end of the roadway furthest from the tree, while the end nearest the tree was expanded as a small platform of branches and leaves, presumably offering the animal a comfortable place from which to embark on its crossing. The remaining three of these forest traps were built on logs that lay across streams a few metres above the water.

I found three collapsed tree traps dating from 1978; all were in areas of regrowth and crossed tracks leading to gardens. In addition, early in 1980, I located five exploratory efforts. These consisted of either a tentative roadway positioned in its forked pole or the roadway alone. All were in regrowth. They were intended to be adopted as convenient runways by animals. Claw marks on the roadway, or droppings beneath it, would show when the roadway was in use and prompt construction of the trap itself. I was told preliminary efforts of this sort were a regular practice. One of these trial roadways was established in February but no trap had been built by April. The others were seen in April.

SPRING SNARES

Springs snares, built to take cassowaries, had a deceptively flimsy appearance. This was because they were almost entirely mechanism with very little housing. Figure 5 illustrates the design of a cassowary snare. The housing consisted of two slender poles or saplings tied to form an 'A-frame', about 60 centimetres wide at the base and 80 centimetres high. This frame straddled a likely or known runway of an animal. A strong, pliant sapling three or four metres away was trimmed and bent down towards the apex of the 'A'. A loop of vine fastened to this passed beneath the apex to hold the toggle which, in turn, exerted force on the horizontal trigger stick — the high set cross-piece of the 'A' — holding it firmly against the legs of the frame. Another length of vine, which had to be strong though slender, connected the trigger stick to a root or rock at ground level. This thread would catch in the feathers of a cassowary that stooped to pass under the frame and would

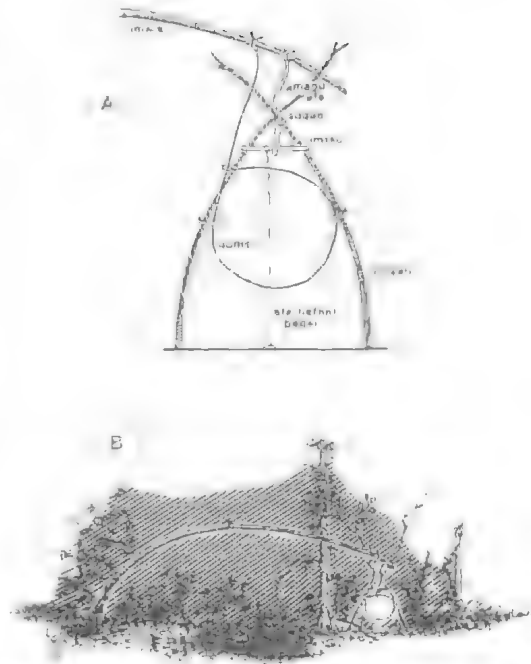


FIG. 5. Spring snare. A — plan excluding the sprung sapling. B — sketch to show snare set in forest. Etolo names for parts are shown on diagram A. They are listed hereafter together with English equivalents. *Sisigali*, supporting 'A' frame; *imele*, sprung sapling; *amagu efe*, loop passing from *imele* beneath the tip of the 'A' frame; *sogae*, toggle; *imisu*, trigger stick; *efe nefani hegei* (= string, not too small, holding), slender but strong vine running from trigger stick to a rock or branch on the ground; *gome*, noose.

pull the trigger stick free from the toggle to spring the trap. A noose of cane or bamboo lying within the frame, with its free end tied to the sprung sapling, was drawn tight as the released sapling swung rapidly upwards. This noose rode 20 to 25 centimetres above the ground and was itself about 40 to 45 centimetres high by 35 centimetres wide. It was tied onto the frame by short lengths of vine designed to break under strain. The trap was completed with a rough barrier of dead sticks and small saplings extending a few metres either side of the frame. This cut off alternate routes around the snare. In appearance the barrier was an inconsequential, almost trivial, structure; it hardly befitted the talents of trappers whose purpose was serious. A cassowary could push through it effortlessly. I can only conclude the birds were easily led, being disinclined to step through minor barriers, or were very wary, avoiding paths that showed signs of overt interference.

The four cassowary snares I saw were in forest.

Two were slightly to one side of the crest of a ridge where this fell away very steeply. A human trail followed the ridge and both snares were at places where an animal following the path might turn off the ridge or where an animal coming up the slope would be channelled by embankments and cliffs towards the ridge. The other two snares were at small streams. Both were built across infrequently used human trails at places where topography restricted the choice of routes across the streams. I am uncertain how many cassowary snares may have been set in 1979. At least six men operated them and one had built four or five. I was told megapodes were occasionally taken in cassowary snares.

There were two other varieties of spring snare. One was a miniature built on the known runway of a game mammal and the second a robust model for wild pigs. The former type was rarely made by Etolo. The only one built in 1979 was the work of a Huli pastor then living at Bobole. The low fence either side of the snare was of strong stakes. No pig snares were built. The only difference between a pig and a cassowary snare, apart from the more powerful construction of the former, was the addition of a rope from the sprung sapling to a nearby tree. This provided an emergency holdfast should the captured pig be able to uproot the sapling.

CLASSIFICATION

Figure 6 records major themes of Etolo classification of traps. The taxonomy had four levels. At higher levels named categories conformed to formal models of taxonomic structure in being exclusive. At the lower level of the taxonomic hierarchy traps were classified using cross-cutting criteria and category exclusiveness broke down.

Sane was the Etolo word for trap. A few simple devices used to lure animals into confined quarters were excluded from this notion. A *sane* had working parts; the quarry effectively suicided by operating a trigger. The first separation of traps was into those that did and those that did not incorporate a drop log. The former were also named *sane*; the latter were *gae* or *gae sane*. Deadfall and tree traps comprised the first category, spring snares comprised the second. For Etolo the criterion of separation concerned the action of the trap after it had been triggered. They described the release action of a *sane* (restricted usage) as "quickly fall down" and of a *gae sane* as "quickly go up". The contrast between logs, in deadfalls, and nooses, in tree traps and spring

snares, as the instruments of death was not a taxonomic marker.

Sane, in restricted usage, were further separated as *dala sane*, or *nagataia sane*, (i.e. deadfalls) and *eŋe sane*, or *ilibia sane*, (i.e. tree traps). *Dala* was one word for a fence and here referred to the two lines of stakes which formed the avenue of a deadfall. *Eŋe* was string or rope and referred to the rope work of the cage of the tree trap. *Nagataia* ('ground on') and *ilibia* ('tree above') referred to the locations of deadfalls and tree traps respectively.

Within each of the three categories of trap defined above (i.e. *dala sane*, *eŋe sane* and *gae sane*) further distinctions were based in either the location or form of the trap or the sorts of animals it was designed to catch. Cross-cutting categories were formed by these distinctions. To Etolo the context of communication was more important than taxonomic precision. Thus, for *dala sane*, two sets of subordinate categories may be recognised — at least by the analyst! The first concerned the sorts of animals being pursued, the second gave information concerning the location or form of the traps. In the first case *ebele sane*, *oheo sane*, *hatagaui sane* and *segeligi sane* were designed, ideally, to capture the sorts of animals named; i.e. small mammals, larger (= game) mammals, terrestrial cuscus and wild pig respectively. In the second case *sege sane*, *nogo sane*, *samie sane* and *gogoi sane* were, respectively, isolated deadfalls scattered in regrowth and forest (*sege* = place), deadfalls positioned on the runways of mammals (*nogo* was a Betamini word for path), deadfalls set over the lairs of mammals (*samie* = to sit down and rest) and series of deadfalls within drift fences (the root of *gogoi* connoted down below, at lower altitudes, and the word was used here to denote the low fence hugging the ground and connecting one trap with another). These two sets of terms intersected in various ways. *Sege sane* would usually qualify as *ebele sane* (i.e. small mammal trap) but were readily renamed *oheo sane* if, by chance, they produced larger mammals. *Nogo sane* could include short lengths of fence and thus be *gogoi sane*. These two categories of trap were always *oheo sane* and, in my experience, *samie sane* equated to *hatagaui sane*. *Hatagaui* (terrestrial cuscus) were included within the primary taxon *oheo* and, in this sense, *hatagaui sane* could be regarded as a type of *oheo sane*. I did not hear anyone speak of *hatagaui sane* in this way and suspect the taxonomic finesse my words imply was neither of importance nor interest to Etolo. *Gogoi sane* were also regularly named *sane yaŋi* or *sane*

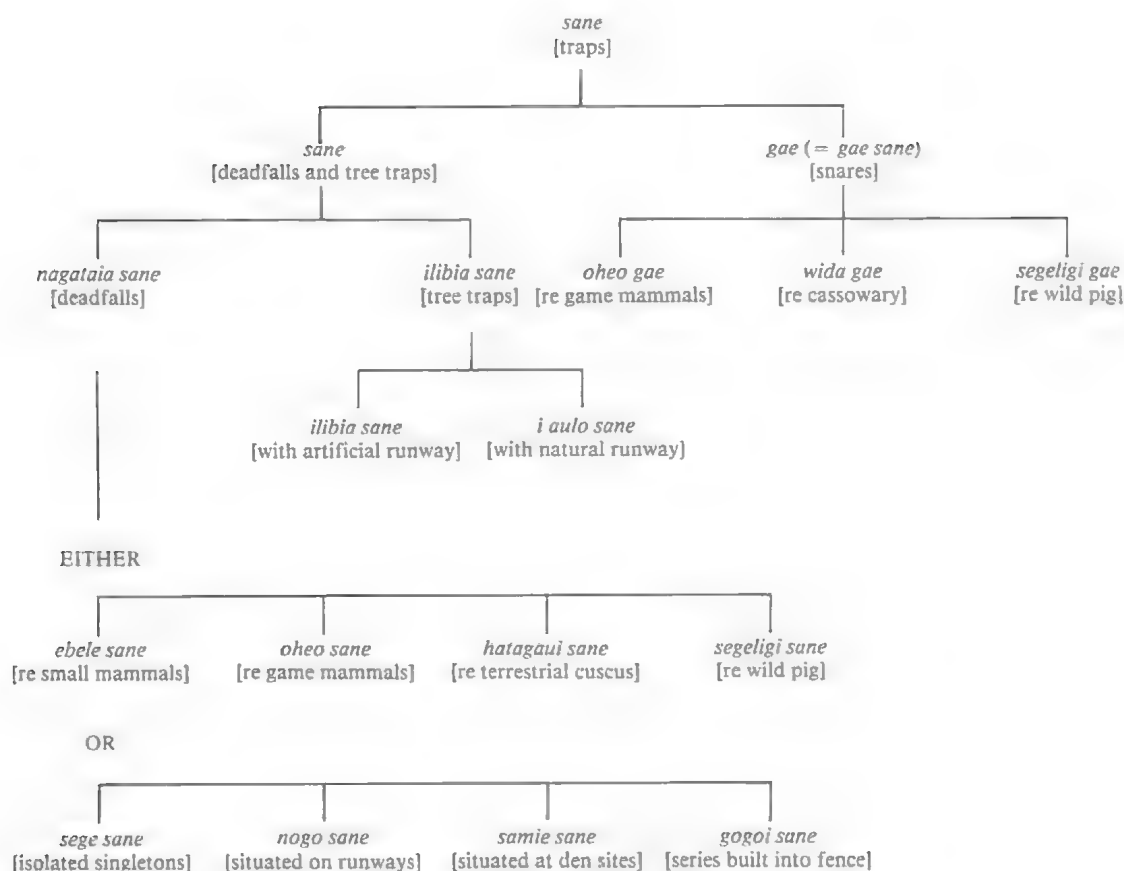


FIG. 6. Etolo classification of traps.

fani, many traps or true traps, and on one occasion a system of traps was named *yala sane* where *yala* was a term for a garden fence. *Iti sane* was occasionally used instead of *nogo sane* (*iti* was an Etolo word for path). *Afate sane* ('one trap') was often used for single deadfalls, and, in this way, contrasted with *sane yafi* ('traps many').

Tree traps (*efe* of *ilibia sane*) were divided as *ilibia sane* (those in which the arboreal runway had been made by people) and *i aulo sane* (those incorporating natural runways such as logs across streams; *aulo* referred to 'bridges' of this sort). Spring snares (*gae*) were classified as *oheo gae*, *wida gae* and *segeligi gae* according to the intention to obtain game mammals (*oheo*), cassowary (*wida*) or wild pig (*segeligi*) respectively. Snares for cassowary were sometimes *wida sane* and both *oheo gae* and *wida gae* could be *nogo gae* if they had been built across a runway.

The legends to Figures 1 and 3 to 5 list Etolo names for parts of traps and record the etymology of those names when known to me. Several comments are warranted. First, there was an elaborate lexicon describing the anatomy of traps. Second, functionally analagous parts were nearly always given the same name in different types of traps. In this regard the following are noteworthy. (a) In the spring snare the loop of vine connecting the sprung sapling to the toggle was named *amagu efe* (hoist rod string) despite the absence of a hoist rod in the snare. (b) In deadfalls built to capture game mammals and wild pigs and in spring snares the rather different structures that held the upper tip of the toggle in position were all named *sisigali*. Only in smaller deadfalls did the word *sisigali* ('bending into an arch or hoop') describe the form of the structure to which it referred. In the snare the use of *sisigali* for the entire 'A' frame stretched

the literal meaning of the term and stressed only a part of the function of that frame. In tree traps the functional analogue of the *sisigali* was reduced to a slender rod and named *mumugu*. (c) The *osogolo* (forked stick) of tree traps was not functionally analagous to that of deadfalls. Third, I was unable to elicit etymological information for the Etolo names given to drop log, hoist rod, toggle, trigger stick or noose (s) in any traps; these were the key functional components of the traps.

COMMENT AND SPECULATION

The preceding account of traps, their classification and of names for parts of traps reflects a considerable role for this technological mode. Certainly, through the 12 months where I have data, mammals that were trapped provided a useful amount of protein; in some months they provided most of the animal protein that people received. Both the taxonomy of traps and the anatomical lexicon hint that deadfalls were the most salient traps in Etolo conceptions. Both deadfalls and tree traps were widely used by people living on the Great Papuan Plateau but only snares were employed by their highland neighbours, the Huli. Spring snares were more cryptic than deadfalls and required more care to manufacture. They had also to be placed with more careful attention to runways used by animals. Where faunal abundance has been reduced in consequence of human impact upon habitat trapping with deadfalls, which are often placed with scant attention to the habits of particular prey species, may be less effective than trapping with snares. This opinion fits the little that is recorded concerning distribution of spring snares and deadfalls through Papua New Guinea. From reports that specify the type of trap used for medium sized mammals there seems to be an association between the use of snares and areas of higher population density (e.g. Central Highlands) and the use of deadfalls and areas of lower population density (e.g. Highland Fringe). In areas of lower population density snares may be used for larger game.

The literature is remarkably silent concerning tree traps of the type described in this paper. Perhaps they are hard to see since neither Kelly (1977) nor Schieffelin (1975) noted their existence among Etolo and Kaluli respectively. Or perhaps they are not in common use through Papua New Guinea. These elegant traps combined features of deadfalls and snares. There was no mention of anything like them in Anell's (1960) review. At Bobole 43 of 95 known captures from tree traps

were of Stein's cuscus. This species was most abundant in relatively young regrowth forest and there was much of this in the vicinity of Bobole. Tree traps would be most effective if positioned to exploit arboreal runways used by target species. At Bobole this was often achieved by providing the runway (a pole placed across a trail used by people) and eliminating potential natural runways either side of the artificial one. It would be far more difficult to eliminate competing runways in tall primary forest. Perhaps the distribution of tree traps across New Guinea will be found to correlate with those subsistence modes that create large expanses of second growth forest. This may be most likely where the intensification of gardening is at intermediate levels as, for example, where garden produce and starch from sago palms are of similar dietary importance. Thus, it may be more than coincidence that Ellen (1975) reported 'weighted noose traps' (i.e. tree traps) in 'series of up to twenty' used in areas of secondary forest by the Nuaulu of Seram.

ACKNOWLEDGEMENTS

I thank the University of Queensland for granting periods of leave, the Department of Biology, University of Papua New Guinea for giving me affiliation and the Government of Papua New Guinea for research visas. Kristine Plowman and Bruce Dwyer accompanied me in the field and gave much help. My debt to everyone at Bobole is great.

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REVISIONARY NOTES ON THE GENUS *PAUOPSALTA* GODING AND FROGGATT (HOMOPTERA: CICADIDAE) WITH SPECIAL REFERENCE TO QUEENSLAND

A. EWART

Ewart, A. 1989 11 13: Revisionary notes on the genus *Pauopsalta* Goding and Froggatt (Homoptera: Cicadidae) with special reference to Queensland. *Mem. Qd Mus.* 27(2): 289-375. Brisbane. ISSN 0079-8835.

Ten new species of Queensland *Pauopsalta* are described: *P. corticinus*; *P. fuscata*; *P. collina*; *P. aktites*; *P. opacus*; *P. vitellinus*; *P. virgulatus*; *P. siccanus*; *P. ayrensis*; and *P. aquilus*. The following new combinations are proposed (including non-Queensland species): *P. rubea* (Goding and Froggatt), a new senior synonym of *Cicadetta geisha* Distant; *P. marginata* (Leach); *P. eyrei* (Distant); *P. rubristrigata* (Goding and Froggatt); *P. infusata* (Goding and Froggatt); and *P. dolens* (Walker). Redescriptions are given of the following species: *P. mneme* (Walker); *P. melanopygia* (Germar); *P. extrema* (Distant), which is reinstated as a valid species; *P. infrasila* Moulds; *P. encaustica* (Germar); *P. nigristriga* Goding and Froggatt; *P. annulata* Goding and Froggatt; *P. elgneri* Ashton; and *P. basalis* Goding and Froggatt, which is treated as a new senior synonym of *P. endeavourensis* Distant. Oscillograms of calling songs are provided for eighteen species and the gross song structures are shown to be species-specific, although significant intraspecific regional variability does occur. Based primarily on male genitalia, five species-groups are recognised: the *P. mneme*, *P. marginata*, *P. annulata*, *P. aquilus* and *P. basalis* groups.

□ *Cicadas, Queensland, taxonomy, insect song, acoustic communication, insect ecology.*

A. Ewart, Department of Geology and Mineralogy, University of Queensland, St Lucia, Queensland 4067, Australia; 3 April, 1988.

The Cicadoidea are a large group of homopterous insects that are especially abundant in the sub-tropical and tropical regions of the world. One hundred and ninety-five species have been described from Australia (Moulds, in press) where the group is well noticed by the general public because of their conspicuous songs. These calls are produced by specialised tymbals situated on either side of the male cicada, between the abdomen and mesothorax. Corresponding organs, the tympana, situated on the undersides of the abdomen of both males and females, are acoustic receptors that are sensitive to the males' calls. Although other Homoptera have similar structures for generating and receiving sounds, only the cicadas produce conspicuous airborne calls and possess highly specialised auditory organs. These calls are apparently species-specific (e.g. Claridge, 1985).

The taxonomy of the Australian cicadas is based mainly on the pioneer descriptions of Distant (many of which are summarised in his 1906 'Synonymic Catalogue'), the early monograph of Goding and Froggatt (1904), and Ashton (1912a,b; 1914). Goding and Froggatt (1904) divided the Australian cicadas into those with tymbal covers (Cicadinae) and those without (Tibiceninae). The majority of the smaller cryptic species were placed in the latter group under *Pauopsalta* Goding and Froggatt or *Melampsalta* Kolenati. Six cicada families were listed by Duffels and van der Laan

(1985): Tettigarctidae, Cicadidae, Tibicinidae, Tettigadidae, Plautillidae, and Platypediidae. *Pauopsalta*, lacking dorsal hoods covering the tymbals, was placed within Tibicinidae, and in the tribe Cicadettini *sensu* Duffels and van der Laan (1985).

The two main characters of *Pauopsalta* were summarised by Myers (1929a) as follows: head as wide as or a little wider than front of pronotum, and five apical cells on the hind wing. The latter character was shown by Hudson (1927:73,74) to be highly variable. Dugdale (1972:860,879) restricted *Pauopsalta* to Australian species with male genital characteristics that had hypertrophied upper pygophore lobes; no sclerotised ventral support; a long, sclerotised endotheca, often ornamented apically; pseudoparameres usually dorsal, longer than shaft, and often clavate or spinose apically.

Duffels and van der Laan (1985) listed 24 nominal species in *Pauopsalta* and Moulds (1987) added *P. infrasila* from Queensland. I recognise 19 species from Queensland, of which 10 are new. The remaining species are redescribed, including *P. encaustica* (from New South Wales); *P. marginata*, *P. rubea*, and *P. eyrei* which are each transferred from *Cicadetta* Kolenati, while *P. geisha* is treated as a new junior synonym of *P. rubea* and *P. endeavourensis* is a new junior synonym of *P. basalis*.

This work subdivides the Queensland *Pauropsalta* species into natural groupings. Extensive use is made of male genital structures, which are valuable for generic classification (e.g. Dlabola 1962, 1963; Orian 1963; Dugdale 1972; Duffels 1965, 1968, 1970, 1977, 1983) and also important at the species level. Where possible, oscillograms of the male songs are provided because these are particularly important as isolating mechanisms (e.g. Fleming 1975) and thus useful in differentiating morphologically similar species.

MATERIAL AND TECHNIQUES

Terminology follows Duffels (1977), Moulds (in press), Dugdale (1972), and Distant (1906a). Ranges and means are presented for five measurements (in mm): fore wing length; body length (which is the maximum length between apex of postclypeus and apex of pygophore or ovipositor); width of head (maximum transverse dimension across outer margins of compound eyes); and widths of pronotum and abdomen (maximum transverse dimensions, the latter across tegite 2).

Song recordings were made with a Grundig TK3200 portable reel-to-reel tape recorder, at a tape speed of 19 cm/s. Oscillograms of the tapes have been prepared in the laboratory facilities of Dr D. Young, Department of Zoology, University of Melbourne, at film speeds of 2.5, 10 and 50 cm/s. Only calling songs have been studied. Although recordings have been made in the field, it has frequently been found desirable to record the insects in boxes or cages. By varying the lighting, cicadas can usually be induced to emit their normal calling songs. In this situation, unwanted background noises can be eliminated. As well, it overcomes the difficulty of closely approaching *Pauropsalta* species in the field because they are very wary. Song terminology follows that of Young and Josephson (1983).

Specimens examined belong to ten institutions and three private collections. These are: BMNH — British Museum (Natural History), London; HEC — Hope Entomological Collections, University Museum, Oxford; MNDN — Museum National D'Histoire Naturelle, Paris; ANIC — Australian National Insect Collection, Canberra; MV — Museum of Victoria; AM — Australian Museum, Sydney; MM — Macleay Museum, University of Sydney; QM — Queensland Museum, Brisbane; UQIC — Insect collection, Entomology Department, University of Queensland; SAM — South Australian Museum; personal collections belonging to M.S. Moulds, Sydney (MSM), Dr. J. Moss, Brisbane (JM), and the author (AE).

PAUROPSALTA GODING AND FROGGATT

Pauropsalta Goding and Froggatt, 1904:615 (gen.n), 565,596; Distant, 1905:269,272; Distant, 1906a:171,174; Distant, 1906b:163,178; Distant, 1907c:246; Froggatt, 1907:354; Oshanin, 1908:399; Bergroth, 1911:188; Horváth, 1911:607; Ashton, 1912b:27; Ashton, 1912c:80; Horváth, 1912:605; Oshanin, 1912:96; Ashton, 1914:355; Hardy, 1918:71; Davis, 1920:125; Distant, 1920:376; Myers, 1922:9; Myers, 1923:430; Handlirsch, 1925: 1116; Kato, 1926:151; Tillyard, 1926:161; Hudson 1927:73; Myers, 1928:391; Haupt, 1929:230; Myers, 1929a:29; Kato, 1932:38,111,386; Schulze, Kükenthal and Heider, 1933:2548; Haupt, 1935:151; Neave, 1940:628; Cooper, 1941:295; de Seabra, 1942:7; McKeown, 1944:235; Metcalf, 1944:156; Metcalf, 1947: 163; Gomez-Menor, 1951:11; Kato, 1956:25; Gomez-Menor Ortega, 1957:29,77; Dlabola, 1963:50; Metcalf, 1963:401-402; Dugdale and Fleming, 1969:936-937; Dugdale, 1972:856,860-861,877,879-880; Nast, 1972:151; Holloway 1979:235; Duffels and van der Laan, 1985:300.

TYPE SPECIES

P. leurensis Goding and Froggatt, 1904:615, by original designation, a junior synonym of *P. mme* (Walker, 1850), synonymized by Distant, 1905:272.

DESCRIPTION

♂ *genitalia*: Long sclerotised endotheca, often ornamented apically; upper pygophore lobes hypertrophied to a pair of blinker-like structures extending posteriorly from pygophore; a pair of hooked processes on claspers either side of endotheca; beak acute and prominent, pointed apically; pseudoparameres joined to endotheca near base, commonly extending apically beyond endotheca, and often clavate or spinose apically; gonocoxite IX bifid with median furrow.

Tymbals: With five ridges (only the dorsal ridge being relatively short) and four inter-ridge sclerites.

Wings: Hyaline; anal margins of hind wings with infuscated spots adjacent to distal end of vein 2A, plus a weak infuscation in clavus (adjacent to plaga); a less obvious infuscation on the fore wings, along the vein 1A + 2A, extending to and darkening towards the junction with veins CuP and CuA₂ (this infuscation absent in *P. eyrei*). The intensity of infuscation varies between species.

Dimensions (Fig. 1a-c): This genus comprises small to small-medium-sized cicadas (10-25 mm body length), which exhibit constant proportional increases in dimensions of body length, head, pronotum, and abdomen with increasing fore wing length. All species exhibit significant variability of

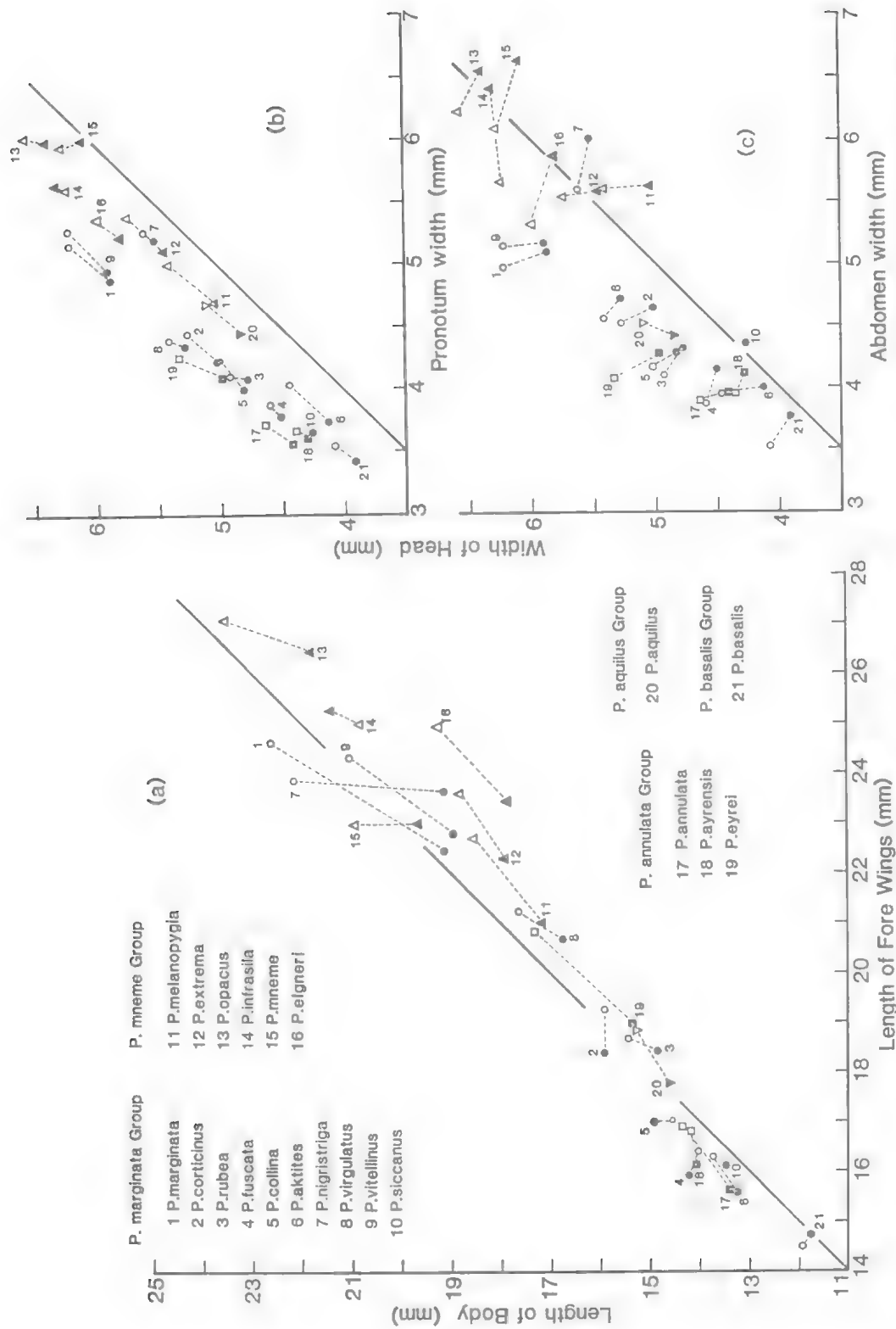


FIG. 1. Plots, in mm, of (a) mean fore wing length versus mean body length; (b) mean widths of head versus pronotum; (c) mean widths of head versus abdomen. The numbers indicate the species as listed. \bullet , \circ are plotted as solid symbols; Δ , \square as hollow symbols; data for same species joined by dotted lines. Only data for which $n > 5$ are plotted. In each plot, the lines represent 1:1 slopes.

these linear dimensions, within the range of 10-20% of the mean values.

REMARKS

The Queensland members of the genus are active between September to May. They tend to be highly cryptic, fast flying, and wary insects with a preference for open forest habitats (dry sclerophyll), extending to suburban gardens with one species being fully coastal. The insects typically rest on shrubs and trees, at heights varying from ground-level to 15-20 m, and may be heard singing at almost any time of day from sunrise to dusk with a noticeably quiescent period in the early afternoon.

RELATED GENERA

The most closely related genus to *Pauropsalta* is *Ueana* Distant from New Caledonia which shows similar genital specialisations (upper pygophore lobes hypertrophied; long, sclerotised endotheca; dorsal pseudoparameres, longer than shaft), although small genitalia differences are apparent (Dugdale, 1972: 879). Tymbal structures are similar, and similar hind wing infuscations are present in both genera. *Ueana* is, however, characterised by an infuscated basal cell of fore wing. In eastern Australia, *Pauropsalta* superficially resembles species of *Notopsalta* and *Cicadetta*, but can be readily distinguished from these two genera by the presence of infuscation spots on the hind wing in *Pauropsalta* and, in the males, by the hypertrophied upper pygophore lobes (not present in *Notopsalta* or *Cicadetta*).

DISTRIBUTION

The species are concentrated along the coastal regions of Australia. In Queensland it occurs mostly along, and to the east of the Great Dividing Range, and extends through Cape York Peninsula. The overall distribution pattern in eastern Australia corresponds to the classical Spencer-Serventy-Whittell Bassian and Torresian zoogeographic subregions (*sensu* Keast, 1981). One species is confined to the semi-arid subregion (*P. siccanus*), while a second species (*P. eyrei*) has an extensive coastal distribution, northwards from central Queensland and extends through northern Queensland westwards into the Mt Isa area. One species (*P. collina*) is confined to the Great Dividing Range and adjacent high granite country of southeastern Queensland and northeastern New South Wales, extending locally into the sandy soil environments of the western slopes. *P. aktites* is restricted to coastal vegetation on, and immediately behind, the strand and foredune complex.

The distribution of some species (e.g. *P. corticinus*, *P. fuscata*, *P. aktites*, *P. annulata*) extends from southern New South Wales to central, and northern central Queensland, with no evidence for a discontinuity in the Macpherson-Macleay overlap region (*sensu* Littlejohn, 1981, and Keast, 1981). Of interest, however, is the occurrence of outlying populations in southern central Queensland, and of certain of the species in the topographically high plateaux (and associated valleys) of the central highlands (e.g. Carnarvon and Mt Moffatt National Parks), the Blackdown Tableland, and Kroombit Tops.

Another group of *Pauropsalta* species is concentrated in northern Queensland, northwards from the Ingham region, through the Atherton Tableland, and into Cape York peninsula. Two of these species (*P. virgulatus* and *P. infrasila*), however, have localised southern extensions of their distributions into central Queensland.

Considered in terms of their overall distributional patterns, the Queensland species *Pauropsalta* correspond broadly with the Kikkawa-Pearse-Horton zoogeographic subregions (*sensu* Littlejohn, 1981, and Keast, 1981), that is, a Koskian subregion extending northwards from New South Wales to northern Queensland, and the Torresian subregion of northeastern Queensland, including Cape York.

Another interesting aspect is the relative distributions of the three most northern species considered in this paper. These are very closely similar species, which have discrete distributions along the northern coastal region of Western Australia (*P. extrema*), northernmost Northern Territory (*P. melanopygia*), and northern Cape York Peninsula (*P. elgneri*). This pattern suggests the possibility of isolation and subsequent speciation during, and following the last period of maximum aridity (c. 18,000 BP; Bowler, 1982), which is interpreted to have resulted in expansion of the northern desert margins, coupled with the northerly increase of exposed land areas due to lowered sea level.

INFRAGENERIC RELATIONSHIPS

Based on male genitalia, five species-groups are recognised in this study, of which one is represented by a single species. The following list also includes *Pauropsalta* species not redescribed in this study (these do not occur in Queensland and have not been critical in resolving taxonomic problems within the genus). These are marked with an asterisk.

1. The *mneme* group: Upper lobes extended laterally from pygophore (i.e. along length of

pygophore), forming a pair of relatively narrow, elongated processes. Species included are:

mneme (Walker, 1850), *melanopygia* (Germar, 1834), *extrema* (Distant, 1892b) stat. rev., *infrastella* Moulds, 1987, *opacus* sp.n., *elgneri* Ashton, 1912a.

2. The *marginata* group: Distinctive pair of spine-like, or triangular plate-like processes, inward pointing, extending from the inner lobes of pygophore. Species included are:

encaustica (Germar, 1834), **dolens* (Walker, 1850), stat. rev., comb.n., *corticinus* sp.n., *fuscata*, sp.n., *collina*, sp.n., *siccanus* sp.n., *aktites*, sp.n., *rubea* (Goding and Froggatt, 1904), comb.n., *marginata* (Leach, 1814), comb.n., *vitellinus* sp.n., *virgulatus* sp.n., *nigristriga* Goding and Froggatt, 1904.

3. The *annulata* group: Upper pygophore lobes enlarged and erect; inner lobes enlarged and acutely tapering, and posteriorly pointing. Species included are: *annulata* Goding and Froggatt, 1904, *ayrensis* sp.n., *eyrei* (Distant, 1882), comb.n., **rubristrigata* (Goding and Froggatt, 1904), comb.n..

4. The *aquilus* group: Upper pygophore lobes enlarged, ascending, with relatively acute distal terminations; claspers thickly ridged and rounded. Species included are:

aquilus, sp.n., **infuscata* (Goding and Froggatt, 1904), comb.n..

5. The *basalis* group: Upper, inner, and lower pygophore lobes well defined and ascending. This species-group is the most divergent of the *Pauropsalta*. Species included is:

basalis Goding and Froggatt, 1904.

The following species, although formally included by various authors within *Pauropsalta* (Goding and Froggatt, 1904; Metcalf, 1963; Duffels and van der Laan, 1985), do not possess the characteristic *Pauropsalta* morphology as defined in this work and are therefore excluded from the above species-groups. Their generic status, in most examples, requires further study:

P. bellatrix Ashton, 1914 (Warren River, Western Australia), *P. dameli* Distant 1905 ('Australia'), *P. emma* Goding and Froggatt, 1904 (Rockhampton, Queensland), *P. exaequata* (Distant, 1892a) (Naga Hills, India), *P. fuscomarginatus* Distant 1914 (540 miles west from Sydney, New South Wales), *P. lineola* Ashton 1914 (Western Australia), *P. mimica* Distant, 1907b (Grahamstown, South Africa), *P. minima* Goding and Froggatt, 1904 (Northern Territory, South Australia), *P. mixta* Distant, 1914 (Brewarrina District, New South Wales), *P. signata* Distant,

1914 (Cue, NW Australia), *P. stigmatica* Distant, 1905 (Adelaide, South Australia), *P. subolivacea* Ashton, 1912a (New South Wales), *P. vernalis* Distant, 1916 (Luzon, Mt Makilling, Philippine Islands).

NOMINA DUBIA

The following names (represented only by female specimens), although considered *Pauropsalta* (i.e. have infusate spots on hind wing), could not be allocated to species-groups because of the absence of authentically associated males:

P. borealis Goding and Froggatt, 1904 (Northern Territory; South Australia), *P. castanea* Goding and Froggatt, 1904 (Karth; ?South Australia), *P. extensa* Goding and Froggatt, 1904 (Murray River, South Australia), *P. nodicosta* Goding and Froggatt, 1904 (Kalgoorlie, Western Australia), *P. prolongata* Goding and Froggatt, 1904, stat. rev. (Australia), *P. rubra* Goding and Froggatt, 1904 (Sale, Victoria).

KEY TO MALES OF QUEENSLAND PAUROPSALTA SPECIES

In view of the difficulties encountered in unambiguously assigning female specimens to species, the following key is constructed only for males.

1. Upper pygophore lobes extended as elongated (finger-like) processes, relatively acutely terminated..... 2
Upper pygophore lobes not finger-like or acutely terminated (i.e. are blinker-like or bladed, with broadly hooked, rounded, or flat terminations)..... 6
2. Body length <13 mm..... *basalis*
Body length >16 mm..... 3
3. Sternites III to VII red to reddish-brown ...
..... *mneme*
Sternites not red to reddish-brown (colouration yellow, yellow-brown, or orange-brown) 4
4. Tergites 3 to 6 yellow to yellow-brown; two topmost tymbal ridges fused dorsally (medially) (Fig. 7F) *elgneri*
Tergites 3 to 6 not yellow or yellow-brown (colouration ranging from black, brown, to orange-brown); top tymbal ridges not fused 5

5. Hind wing infuscations conspicuous but small; (tergites 3 to 7 black to deep brown with pale brown to orange-brown posterior margins) *opacus*
Hind wing infuscations faintly developed and small; (tergites 3 to 7 orange-brown, darker dorsally) *infrasila*
6. Dorsal tymbal ridge not extending across dorsal inter-ridge sclerite 7
Dorsal tymbal ridge extending across to, or beyond, outer (lateral) edge of dorsal inter-ridge sclerite 12
7. Rostrum extends to hind coxae .. *nigristriga*
Rostrum not extending to hind coxae 8
8. Upper pygophore lobes with acutely angulated terminations (i.e. broadly hook-like shape); colouration of lobes not black.. 9
Upper pygophore lobes without angulated terminations (extending laterally as terminally rounded, paddle-like blinkers; Fig. 16B); colouration of lobes black..... *corticinus*
9. Sternites III to VI predominantly (>90%) black to deep brown *collina*
Sternites III to VI not predominantly black to deep brown (<50%; colouration yellow, yellow-brown, orange-brown, reddish-brown, brown, with or without dark median longitudinal fascia)..... 10
10. Sternites III to VI with dark median longitudinal fascia — remaining colouration orange-brown, reddish-brown, brown, or yellow-brown 11
Sternites III to VI with no darker median fascia, colouration being orange-brown *virgulatus*
11. Two clearly defined infuscation spots on each hind wing, the second infuscation adjacent to plaga; thickly developed tymbal ridges (Fig. 26F) *siccanus*
One clearly defined hind wing infuscation spot, weakly developed (anal margin, distal end of vein 2A); tymbal ridges relatively thinly developed (Fig. 33F)..... *marginata*
12. Sternites III to VI predominantly (>90%) black to deep brown 13
- Sternites III to VI not dominantly black to deep brown (<50%; colouration orange, orange-brown, yellow, yellow-brown, reddish-brown, pale brown, with or without dark median longitudinal fascia) 14
13. Upper pygophore lobes terminally rounded with conspicuous hook-like shape (Figs 19B-22B); rostrum extends to mid coxae *fuscata*
Upper pygophore lobes not terminated in hook-like form (Fig. 50B); rostrum extends to hind coxae *aquilus*
14. Upper pygophore lobes terminated in a broad hook-like shape..... 15
Upper pygophore lobes not terminated in conspicuously hook-like shape; (lobes blinker-like with rounded or flat terminations 17
15. Tergite 8 dominantly (>75%) black (tergites 3-7 orange to yellow-brown, with or without subordinate narrow darker bands; sternites III to VI orange, orange-brown, or yellow). *vitellinus*
Tergite 8 not dominantly black (tergites 2-8 each black anteriorly, otherwise reddish-brown; sternites III to VIII yellow-brown to reddish-brown, with or without dark central fascia)..... 16
16. Hind wing infuscation spots clearly developed; dark median longitudinal fascia on sternites well developed..... *rubea*
Hind wing infuscation spots weakly developed; median longitudinal fascia on sternites absent or only weakly developed ... *aktites*
17. Tergites 2 to 7 yellow to orange; tergite 8 mostly (>80%) black *eyrei*
Tergites 2 to 8 black with narrow orange brown, yellow, to yellow-brown posterior margins 18
18. Tergites black with prominent orange-brown to orange posterior margins; endotheca broadened apically (i.e. 'trumpet-like'; Fig. 46D) *ayrensis*
Tergites black with yellow to yellow-brown posterior margins; endotheca curved and clindrical, not broadened apically (Fig. 42D) *annulata*

P. MNEME SPECIES-GROUP***Pauropsalta mneme* (Walker)**
(Figs 2,3,4A,B)*Cicada mneme* Walker, 1850:181; Dohrn, 1859:74.*Cicada antica* Walker, 1850:182; Dohrn, 1859:74; synonymized by Stål, 1862:482.*Melampsalta mneme* (Walker) Stål, 1862:484; Myers, 1929b:218; Kato, 1932:32, fig. 37D, 187, plate 23, fig. 8; Burns, 1957: 658-659; Greenup, 1966:62-63.*Melampsalta mnemae* (sic) (Walker) Stål, 1870:718; Distant, 1892a:144.*Pauropsalta mneme* (Walker) Goding and Froggatt, 1904:622-623; Distant, 1906b:178; Froggatt, 1907:354; Kirkaldy, 1907:309; Ashton, 1912b:27; Horváth, 1912:605; Ashton, 1914:355; Hardy, 1918:71; Tillyard, 1926:161, plate 12(18); Metcalf, 1963:409-410; Dugdale, 1972:860,866,878, figs 4,14; Young, 1972:238,241-242, plates 1G,111C; Duffels and van der Laan, 1985:302.*Pauropsalta leurensis* Goding and Froggatt, 1904:616-617, plate 18, figs 8,8a; synonymized by Distant, 1905:272; Davis, 1920:125.

MATERIAL EXAMINED

LECTOTYPE: ♂ of *Cicada mneme*, here designated, in BMNH. Syntype (blue) and type (green) labels on specimen. No locality data. No ♀ syntype apparently in collection, although its presence is indicated in original description.HOLOTYPE: ♂ of *Cicada antica*, in BMNH, bearing green type label. No locality data.SYNTYPES: ♂ and ♀ of *Pauropsalta leurensis*, in ANIC: Blue Mountains, New South Wales. Ex MM and 'on permanent loan'.

OTHER MATERIAL: 5♂♂, 2♀♀ from following localities. QUEENSLAND: 'Queensland' (BMNH). Eukey; Glen Aplin (MV). Girraween N.P. (UQIC). Girraween N.P.; Wyberba, S of Stanthorpe (MSM).

DESCRIPTION

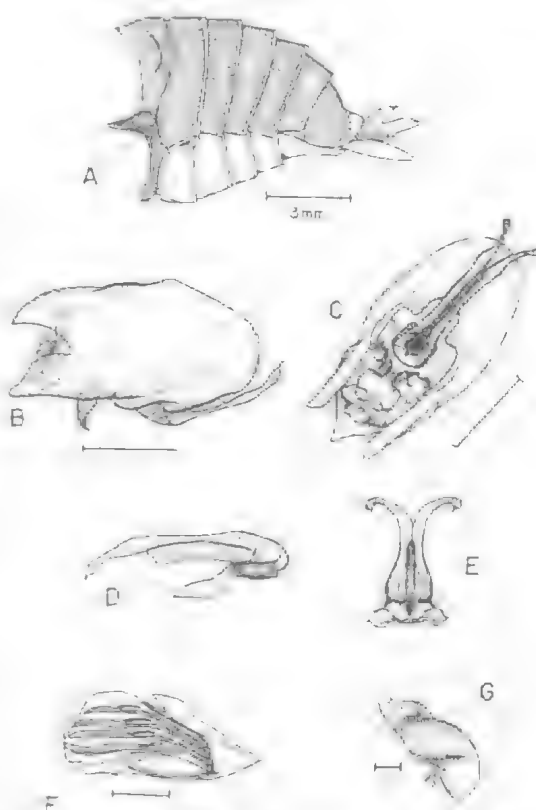
MALE: Head: Predominantly black. Postclypeus shiny black anteriorly with brown margin; small brown spot dorsally on midline; dorsal surface black with pale brown central triangular area, the apex terminating at midline; pale pubescence on anterior and dorsal surfaces. Anteclypeus shiny black with pale pubescence. Rostrum dark brown, becoming black apically; extends to mid coxae. Gena and mandibular plate black with pale brown marginal ridge and conspicuous pale pubescence; intervening pale brown triangular area adjacent to postclypeus. Antennae deep brown. Ocelli dark red. Eyes dark to medium brown. Dorsal surface of head black with pale brown fascia situated in longitudinal suture between ocelli; conspicuous pale pubescence, especially behind eyes. Vertex lobes shiny black.

FIG. 2. *Pauropsalta mneme* (Walker) ♂, type species of the genus *Pauropsalta*. A: Abdomen, viewed from left laterally, showing extent of darker pigmentation. Scale equals 3 mm. B: Pygophore, viewed laterally from right side. C: Pygophore, viewed from ventral aspect. D: Aedeagus, viewed laterally. E: Aedeagus, viewed from anterior aspect to show structure of gonocoxite IX. F: Left tymbal. G: Left opercula. Based on specimens from Black Mt, A.C.T. Scales represent 1 mm, except where indicated otherwise.

Thorax: Pronotum black with pale brown spindle-shaped central fascia, not extending to anterior or posterior pronotal margins; a pair of small, pale brown dorsolateral semi-circular patches adjacent to pronotal collar; short silver-yellow pubescence.**Mesonotum** black with a pair of narrow pale brown to red-brown dorsolateral fasciae, extending from anterior arms of cruciform elevation; cruciform elevation arms pale brown; wing grooves and adjacent ridges pale brown; pale pubescence conspicuous laterally.**Legs:** Coxae black with narrow pale brown fasciae along margins. Femora black with longitudinal red-brown fasciae on fore legs. Tibiae and

tarsi black to dark brown, becoming paler on hind legs. Claws and spines black to dark brown.

Wings: Hyaline; costal veins of fore wings brown, remaining venation black. Infuscation spots on hind wings, spreading out from distal terminations of 2A veins, are very distinct.

Tymbals: Dorsal ridge short, not extending across dorsal inter-ridge sclerite.

Opercula: Broadly sickle-shaped, rounded along inner (posterior) termination; gently domed medially and shiny; declivous marginal flange, most clearly developed along outer margin; black becoming reddish-brown across posterior area; surface finely rugose.

Abdomen: Tergites black with conspicuous orange posterior margins; narrow reddish-brown zone adjacent to posterior edge to tergite 2; sparse short pale pubescence laterally and dorsolaterally. Sternites red to reddish-brown, with orange to red-brown posterior margins; small dark median areas occur anteriorly on sternites II and VI, and less commonly on sternites III to V.

Genitalia: Pygophore black, medium brown posteriorly; upper lobes elongated laterally, partially twisted, and acutely terminated; claspers sharply pointed and hooked; lower and inner lobes conspicuously bulbous. Aedeagus with dorsal pseudoparameres with clavate and ornamented terminations, extending beyond endotheca.

FEMALE: Essential markings and colouration as for male. Vertex lobes reddish-brown. Pronotum shows additional brown broken colouration adjacent to oblique fissures, and narrow brown to red-brown margin on pronotal collar. Mesonotum with additional pair of narrow reddish-brown lateral fasciae. Tergites have additional narrow red-brown zones adjacent to posterior margins, thickening dorsally; tergite 9 medium to pale brown with pair of black dorsolateral fasciae which in part join posteriorly, and in part decurve sharply posteriorly. Sternite II black; anterior margin of sternite III black, otherwise sternites red to reddish-brown; ovipositor sheath extends only slightly beyond (<1.0 mm) tergite 9.

MEASUREMENTS: 23♂♂ and 11♀♀. Body length: ♂ 16.8-22.1 (19.67); ♀ 18.3-23.1 (20.94). Fore wing length: ♂ 19.8-25.2 (23.03); ♀ 20.3-26.9 (23.00). Head width: ♂ 5.1-6.6 (6.09); ♀ 5.6-7.1 (6.27). Pronotum width: ♂ 5.1-6.9 (6.02); ♀ 5.1-6.6 (5.97). Abdomen width: ♂ 5.8-7.1 (6.62); ♀ 5.1-6.9 (6.08).

DISTRIBUTION

This cicada is widely distributed and common through much of southeastern New South Wales, extending to the Australian Capital Territory,

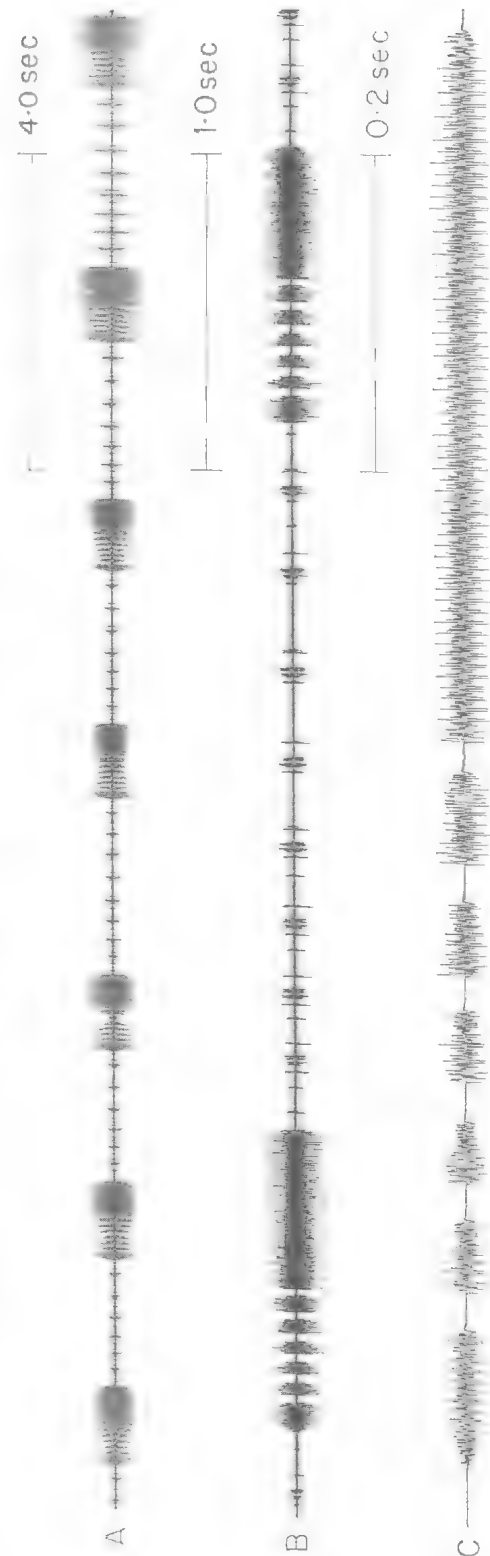


FIG. 3. Oscillograms of calling song of *P. mneme*, recorded from Sutherland, Sydney (JM). The three photographic records are shown for three different time scales, as indicated on the scales.

through Victoria to South Australia in the Adelaide hills, to Orreroo (Moulds, in press). In Queensland, it occurs in the high granite belt country of southeastern Queensland, extending southwards into New South Wales along the northern New England Tableland.

SONG

The main calling song structure comprises sets of seven phrases made up of six short phrase groups followed by a longer, compound phrase group (Fig. 3; see also Young 1972). The initial short phrase group varies from 85-90 msec in length, which reduces to 40-50 msec for the following four phrase groups, lengthening again to 55-60 msec for the sixth (final) short phrase group. The longer, compound phrases last for between 0.42-0.51 sec (based on Fig. 3). Intervals between emission of each of the phrase groups are 20-26 msec, typically becoming slightly shorter as the song progresses. Intervals between the production of each discrete set of seven phrases ranges from 1.6-2.3 sec.

During these intervals between the sets of main compound phrase production, additional isolated short pulse groups are emitted, usually 6 to 8 in number in the available records. These consist, in further detail, of two single, followed by a double, followed by a single pulse subgroups, each quite discrete, with intervening intervals of 10-35 msec.

The finer structure of the various phrase and pulse groups and subgroups can be further resolved by expanded time scale recordings, and are the result of compound pulses (7-8 msec duration) emitted singly, doubly, and in trebles; each of these compound pulses are themselves produced by at least 5 coalescing pulses (indicating carrier pulse repetition frequencies of at least 700 Hz).

COMMENTS

Re-examination of the holotype ♀ of *Pauropsalta prolongata* Goding and Froggatt, 1904, held in ANIC (Ex MM and 'on permanent loan') showed that it is not conspecific with *P. mneme*, although these two species were synonymized by Burns (1957: 658-659); see 'Nomina dubia' list above.

***Pauropsalta melanopygia* (Germar)** (Figs 5,56)

Cicada melanopygia Germar, 1834:59; Walker, 1850:172; Dohrn, 1859:74; Kershaw, 1897:119.

Tibicen melanopygius (Germar) Stål, 1861:618, synonymized by Distant, 1882:132; Goding and Froggatt, 1904:601.

Melampsalta melanopygia (Germar) Froggatt, 1896:531; Froggatt, 1903:420, fig. 1; Kato, 1932:187; Burns, 1957:657-658.

Pauropsalta melanopygia (Germar) Distant, 1906b:179; Kirkaldy, 1907:309; Ashton, 1912a:227; Ashton, 1914:355; McKeown, 1944:234; Metcalf, 1963:408-409; Duffels and van der Laan, 1985:302.

MATERIAL EXAMINED

LECTOTYPE: ♂ of *Cicada melanopygia*, here designated, in HEC (Hem. Type 791 1/3): 'M.I.' (= Melville Island; small white label); 'melanopygia Germ' (blue label).

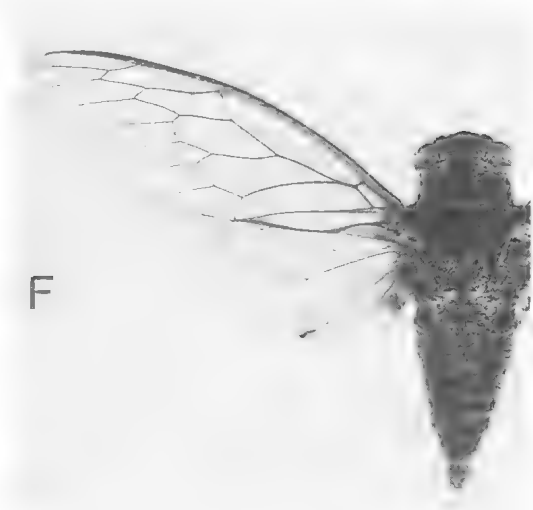
OTHER MATERIAL: 19♂♂, 6♀♀ from following localities. NORTHERN TERRITORY: 15 km E of Mt Cahill (ANIC). Bathhurst Is. (MV). 15 km E of Mt Cahill; 15-17 km E of Mt Cahill; 18 km E of Mt Cahill; Cobourg Peninsula (Smith Pt); Darwin; E Alligator R. crossing via Oenpelli; Elsie Ck, 10 mi. E of Mataranka, on Roper R. Rd; Green Ant Ck, 40 mi. S of Adelaide R.; Melville Is; Z Lagoon to Dip Yard Lagoon, Daly R. (JM). Darwin; Mataranka Hstd, Roper R. (MSM).

DESCRIPTION

MALE: Head: Postclypeus shiny black to deep brown anteriorly; paler broad marginal zone, with pale colouration extending between transverse ridges; distinct pale brown spot dorsally on midline; dorsal surface shiny black; anterior silvery yellow pubescence. Anteclypeus deep brown to black. Rostrum pale brown becoming black apically and extending to hind coxae. Gena and mandibular plate black with pale intervening suture and conspicuous silvery pubescence. Vertex lobes pale to medium brown. Ocelli pink to red. Eyes dark brown. Dorsal surface of head black with narrow pale brown triangular area over longitudinal suture between ocelli; silvery-yellow pubescence especially behind eyes.

Thorax: Pronotum dominantly medium brown with yellow-brown central fascia, anterior margin, pronotal collar, and dorsolateral area behind and adjacent to central fascia; narrow zone immediately adjacent to central fascia deep brown to black; central fascia narrows posteriorly, not reaching pronotal collar; depth of brown colouration between and adjacent to oblique fissures is variable; scattered silvery-yellow pubescence.

Mesonotum with yellow-brown dorsolateral fasciae with irregular outlines, widening sharply medially, but not coalescing, and extending to anterior arms of cruciform elevation; a pair of oblique, broad yellow-brown fasciae coalesce with dorsolateral fasciae close to anterior arms of



cruciform elevation; intervening areas between fasciae black, with wedge-shaped dark brown area adjacent to wing grooves; arms of cruciform elevation yellow-brown with intervening anterior and lateral areas black; fore wing grooves pale orange-brown; silver-yellow pubescence especially conspicuous around cruciform elevation.

Legs: Coxae of fore legs dark brown with yellow-brown lateral and ventral margins; mid and hind coxae patchy brown and yellow-brown; femora medium to dark brown anteriorly, yellow-brown on posterior margins; tibiae and tarsi pale brown to yellow brown; claws and spines medium to dark brown.

Wings: Hyaline; costal veins of fore wings pale yellow brown; remaining venation medium brown, darker around apical cells and ambient vein. Infuscation spots on hind wings relatively faintly developed.

Tymbals: Dorsal ridge extending across dorsal inter-ridge sclerite; lower three ridges joined anteriorly; distinct basal spur.

Opercula: Broadly sickle-shaped, markedly undulate, with relatively acutely tapering inward (posterior) termination (as illustrated in Fig. 5G), although in some specimens more rounded; domed medially; declivous flange along outer margin; predominantly pale yellow to orange-brown with brown colouration restricted to small anterior area; surface finely rugose.

Abdomen: Tergite 2 deep brown along entire anterior margin, otherwise yellow-brown to orange-brown; tergites 3 to 6 orange-brown to yellow-brown with narrow median dorsal dark brown to black bands which rapidly narrow and terminate either side of dorsal surface; tergite 7 orange-brown with median black irregular band extending around most of tergite, terminating at lower edge; tergite 8 black except for irregular pale reddish-brown zone adjacent to posterior margin; posterior margins of tergites yellow-brown. Sternite II brown to black; sternites III to VI, orange-brown; sternite VII mostly dark brown to black; sternite VIII pale orange-brown, in some specimens with anterior brown patches.

Genitalia: Pygophore dark brown anteriorly, pale brown posteriorly; upper lobes elongated laterally, relatively acutely terminated, and somewhat spoon-shaped; prominent ascending and anteriorly strongly curved claspers; prominent ascending median process; dorsal curved

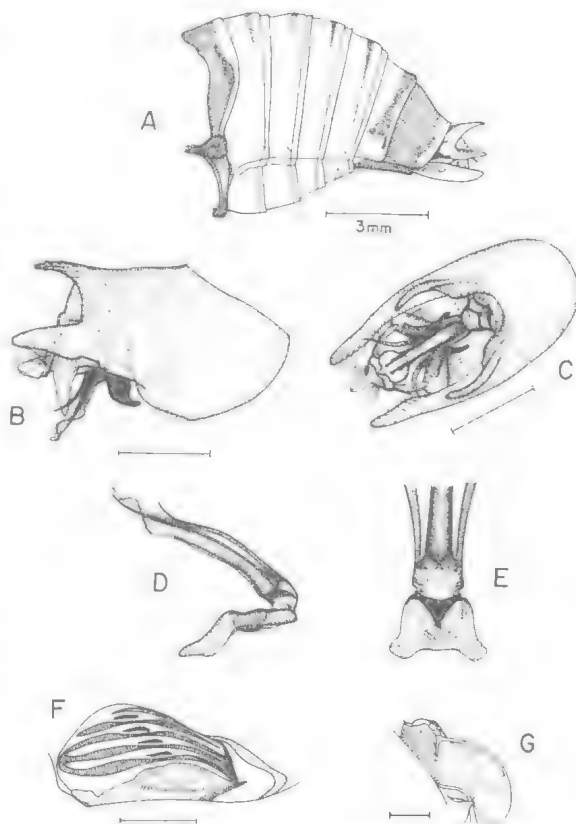


FIG. 5. *Pauropsalta melanopygia* (Germ.) ♂, from specimens in HEC, except for D and E, which are based on specimens from JM collection. Symbols A to G, and scales, as in Fig. 2.

pseudoparameres shorter than endotheca; endotheca with undulating outward flanged termination.

FEMALE: Markings and colouration as in male, with some decrease in extent of darker areas. Pronotum more uniform sandy-brown with medium brown rim around broad central fascia and medium brown broken markings between and adjacent to oblique fissures. Mesonotum shows reduced area of black colouration. Tergites 2 to 8 orange-brown with anterior medium brown bands which terminate laterally and tend to thin and become discontinuous dorsally (especially on tergites 4 to 8); tergite 9 paler orange-brown with a pair of deep brown to black clearly defined dorsolateral fasciae which broaden posteriorly, but do not extend to end of tergite. Sternites pale brown to orange-brown with orange posterior margins; ovipositor sheath extends approximately 2 to 3 mm beyond tergite 9.

MEASUREMENTS: 9♂♂ and 4♀♀. Body length: ♂

FIG. 4. A,B *P. mneme* ♀, ♂. C,D *P. infrasila* ♀, ♂. E,F *P. opacus* ♀, ♂. Each photograph $\times 2$ natural size. Photographs: D.M. Reeves

15.2-19.8 (17.19); ♀ 17.3-20.1 (18.54). Fore wing length: ♂ 17.5-23.4 (21.02); ♀ 21.8-23.4 (22.73). Head width: ♂ 4.0-5.6 (5.03); ♀ 5.3-5.6 (5.40). Pronotum width: ♂ 3.7-5.2 (4.70); ♀ 4.6-5.2 (5.02). Abdomen width: ♂ 4.3-6.4 (5.62); ♀ 5.1-6.1 (5.60).

DISTRIBUTION

Confined to the northern region of Northern Territory (Fig. 56).

COMMENTS

Two ♂ syntypes are identified at HEC (Ewart, in press). The male with the two labels is selected as lectotype and has been labelled as such. The remaining ♂ paralectotype has a single small white label with 'MI' (= Melville Island) written in ink. A third specimen (♂) of less certain status has a white label bearing only a black dot. *P. extrema* is here removed from synonymy. *P. nigristriga* has been removed from synonymy by Moulds (1987).

P. melanopygia superficially resembles *P. extrema*, *P. elgneri*, *P. virgulatus*, and *P. vitellinus*. The latter two species have shorter rostrums (extending to mid coxae, compared to hind coxae of *P. melanopygia*), and also clearly distinguishable male pygophore upper lobe shapes (both broadly hooked) compared to the narrower, tapering lobes of *P. melanopygia*. *P. extrema* is distinguished by the black colouration of tergite 7, opercula shape (Figs 5G, 6G), distinct aedeagus structures in male (Figs 5D, 6D), differing lengths of dorsal tymbal ridge (longer in *P. melanopygia*; Figs 5F, 6F), and differing female ovipositor sheath lengths (longer in *P. melanopygia*). See comments under *P. elgneri* for distinguishing features between *P. melanopygia* and *P. elgneri*.

Pauropsalta extrema (Distant) stat.rev.

(Figs 6, 56)

Melampsalta extrema Distant, 1892b:323-324

Pauropsalta extrema (Distant) Goding and Froggatt, 1904:619.

MATERIAL EXAMINED

LECTOTYPE: ♂ of *Melampsalta extrema*, here designated, in BMNH: 'syntype' (blue label): '*extrema* Dist': '*Ueana melanopygia* Germ.': 'Roebourne N.W. Aust. Saunders': 'Distant Coll. 1911-383.'

PARALECTOTYPE: ♀, in BMNH: 'Roebourne N.W. Aust.' 'Saunders': 'Distant coll. 1911-383'.

OTHER MATERIAL: 24♂♂, 13♀♀ from following localities. WESTERN AUSTRALIA: Drysdale R. at Kalumburu Rd crossing, Kimberleys; Fortescue R. Hammersley Range; Wyndham, Kimberley Res. St. (MV). Millstream; 0.5 km WNW of Millstream; 2 km ENE of Millstream Hstd; Mt Tom Price, Newman (JM).

Fitzroy R. crossing, Derby-Broome Rd; Halls Ck township; Marble Bar; Millstream, Fortescue R., S of Roebourne; Sherlock R.; Yule R., c. 160 km S of Port Hedland (MSM).

DESCRIPTION

MALE: *Head*: Postclypeus with anterior central broad black shiny fascia centred on midline, and orange to yellow-brown margins; conspicuous rounded yellow-brown spot dorsally on midline; dorsal surface predominantly yellow-brown; silvery pubescence. Anteclypeus black, becoming brown apically; silvery pubescence. Rostrum yellow-brown, extending to hind coxae. Gena and mandibular plate black with intervening suture pallid, as is marginal ridge; silvery pubescence. Antennae pale brown, darker apically. Vertex lobes yellow-brown. Ocelli pink. Eyes dark brown. Dorsal surface of head black with small yellow-brown area over longitudinal suture between ocelli; silvery pubescence especially behind eyes.

Thorax: Pronotum yellow-brown with paler

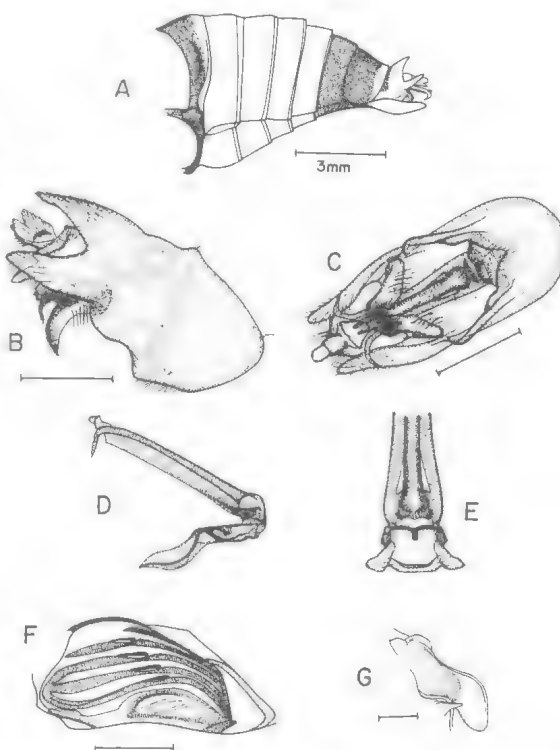


FIG. 6. *Pauropsalta extrema* (Dist.) ♂. Body and opercula from holotype, Roebourne, Western Australia (BMNH); genitalia and tymbals based on specimen from Millstream, Western Australia (JM collection). Symbols A to G, and scales, as in Fig. 2.

central fascia, narrowing posteriorly, but not reaching pronotal collar, and enclosed by deep brown outer rim; broken black to deep brown markings between and close to oblique fissures; anterior margin and pronotal collar pale yellow-brown; pronotal surface uneven with very prominent oblique fissures; sparse silvery pubescence.

Mesonotum dominantly black with a pair of narrow, posteriorly inward curving, orange-brown to yellow-brown dorsolateral fasciae, not reaching cruciform elevation; lateral margins grade from black to brown; cruciform elevation dark brown, becoming yellow-brown along posterior arms.

Legs: Coxae with alternate dark brown and yellow-brown areas, which are longitudinally oriented on fore coxae; femora brown, the colouration paler on hind femora; tibiae and tarsi yellow-brown; claws and spines medium to dark brown.

Wings: Hyaline; costal veins of fore wings pallid, remaining venation pale to medium brown, darker towards apical cells and ambient vein; infuscation spots on hind wings faintly developed.

Tymbals: Dorsal ridge not extending across dorsal inter-ridge sclerite; lower three ridges joined anteriorly; distinct basal spur.

Opercula: Broadly sickle shaped, gently domed in median area, with rounded inward (posterior) terminations; declivous marginal flange around whole margin; bright yellow or orange-brown colouration with variable brown irregular area on median dome; surface finely rugose.

Abdomen: Tergite 2 black to deep brown; tergites 3 to 6 bright orange to yellow; tergites 7 and 8 predominantly black, sometimes with paler posterior margins and small pale dorsal and lateral areas. Sternite II deep brown; sternites IV to VI bright orange to yellow; sternite VII mainly variable brown; sternite VIII orange to orange-brown.

Genitalia: Pygophore brown anteriorly, orange posteriorly; upper lobes elongated, somewhat curved, and acutely terminated; inner and lower lobes conspicuously bulbous; prominent ascending, anteriorly curved claspers, sharp, with complex interdigitated grooves along posterior dorsolateral edges; median process moderately developed; pseudoparameres sharply curved apically, of similar length to endotheca; endotheca cylindrical, nearly straight, with ornamented termination.

FEMALE: Essential markings and colouration as in male. Mesonotum with deep brown rather than

black colouration, and wider and more extensive orange-brown dorsolateral fasciae which coalesce with oblique lateral fasciae adjacent to cruciform elevation; cruciform elevation orange-brown, anteriorly deep brown. Tergites 2 to 6 orange-brown, tending brown on tergite 2; tergite 7 deep brown to black; tergite 8 orange-brown with dark brown to black irregular and variable colouration; tergite 9 orange brown with a pair of longitudinal dark brown dorsolateral fasciae not extending to end of tergite. Sternites orange to orange-brown; ovipositor sheath only extends to posterior margin of tergite 9.

MEASUREMENTS: 19♂ and 12♀. Body length: ♂ 15.2-20.3 (17.93); ♀ 17.3-20.3 (18.82). Fore wing length: ♂ 19.8-25.9 (22.31); ♀ 20.3-25.4 (23.64). Head width: ♂ 4.6-5.8 (5.43); ♀ 5.3-6.1 (5.73). Pronotum width: ♂ 4.8-5.7 (5.12); ♀ 5.1-5.6 (5.40). Abdomen width: ♂ 4.8-6.4 (5.58); ♀ 5.1-6.1 (5.53).

DISTRIBUTION

Occurs widely through the northern zone of Western Australia broadly paralleling the coast, with a gap corresponding to the Great Sandy Desert (Fig. 56).

COMMENTS

In the accessions catalogue in BMNH, item 1911-383 refers to the purchase of the first instalment of Distant Collection (in 1911), comprising 3260 Cicadidae and 2740 moths. Two syntypes of *Melampsalta extrema*, ♂ and ♀, are present in BMNH, the male is selected above as the lectotype. These correspond to the male and female specimens mentioned in the original description, but the original description also indicates the existence of further syntype(s) in AM (not examined).

Although *P. extrema* has been long synonymised with *P. melanopygia* (Distant, 1906b:179), the present study supports their status as distinct allopatric species (see comments under *P. melanopygia*; Fig. 56). *P. extrema* most closely resembles *P. melanopygia*, *P. elgneri* and especially *P. vitellinus*. See comments under *P. melanopygia* and *P. elgneri* concerning distinctions between these species. *P. extrema* is distinguished from *P. vitellinus* by longer rostrum (extending to hind coxae), longitudinally tapering male upper pygophore lobe (hooked in *P. vitellinus*), shorter female ovipositor sheath length, and the predominant black colouration of tergite 7.

***Pauropsalta elgneri* Ashton**
(Figs 7, 8A, B, 56)

Pauropsalta elgneri Ashton, 1912a:227, Pl.LI, figs 10a-b; Metcalf, 1963:406; Duffels and van der Laan, 1985:301.

Melumpsalta elgneri (Ashton) Burns, 1957:650.

MATERIAL EXAMINED

HOLOTYPE: ♂ QUEENSLAND: 'C York 1907 Elgner': 'K67569'; 'P. elgneri type': 'Ashton Coll.': 'Holotype'. AM.

OTHER MATERIAL: QUEENSLAND: 10 mi. N of Rocky R., Via Coen (QM). Archer R. crossing, 60 km N of Coen; Cape York Peninsula; Peach R., Coen (MSM).

DESCRIPTION

MALE: Head: Postclypeus yellow-brown with anterior broad black central fascia extending along, but much wider than midline, becoming wider dorsally and enclosing a yellow triangular area dorsally on midline; dorsal surface yellow. Anteclypeus mostly dark brown to black, paler dorsolaterally. Rostrum yellow-brown, becoming dark apically, and extending to hind coxae. Gena and mandibular plate black with conspicuous silver-yellow pubescence. Vertex lobes yellow-brown. Ocelli pink to red. Eyes dark brown. Dorsal surface of head black to deep brown, paler adjacent to eyes, with yellow triangular area over longitudinal suture between ocelli; yellowish pubescence especially behind eyes.

Thorax: Pronotum pale brown with pale yellow-brown central fascia, anterior margin, and pronotal collar; small black patches at ends of central fascia, and irregular darker brown patches along and near oblique fissures.

Mesonotum: medium to dark brown laterally and dorsolaterally, with a pair of dark brown dorsolateral to dorsal obconical areas adjacent to pronotal collar, and a dark brown area covered in yellow-silver pubescence, anteriorly to cruciform elevation; remaining dorsal and dorsolateral area yellow-brown; cruciform elevation yellow-brown, with a pair of distinct black spots immediately adjacent to terminations of anterior arms; wing grooves yellow with adjacent silver-yellow pubescence, extending dorsally to cruciform elevation.

Legs: Coxae yellow-brown to brown; femora medium brown, becoming yellow towards tibiae; tibiae and tarsi of fore legs medium brown, becoming yellow-brown on mid and hind legs; claws and spines brown.

Wings: Hyaline; venation yellow-brown to brown, generally darker around apical cells and ambient vein.

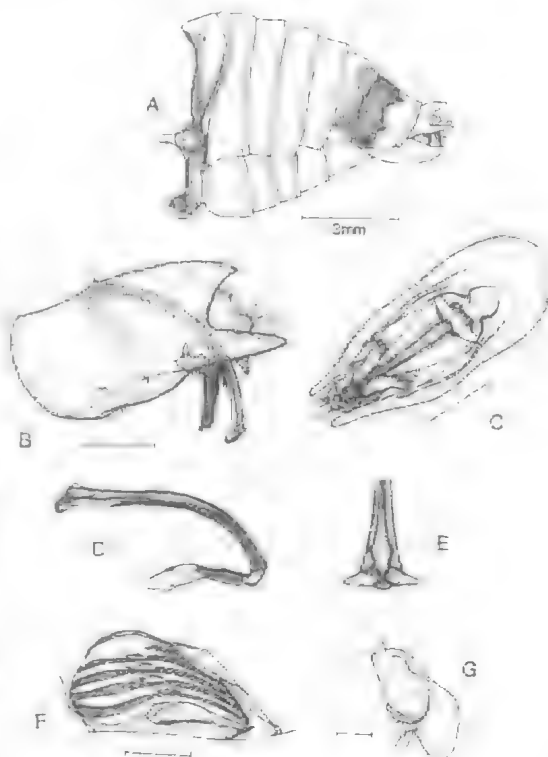


FIG. 7. *Pauropsalta elgneri* Ashton ♂. From specimen from Archer River crossing, 60 km N of Coen, Cape York Peninsula. Symbols A to G, and scales, as in Fig. 2.

Tymbals: Dorsal ridge short and fused posteriorly to adjacent ridge; lower three ridges joined anteriorly; very small basal spur.

Opercula: Broadly sickle-shaped, distinctly bulbous anteriorly; with rounded posterior termination; declivous flange along outer margin; yellow-brown; surface finely rugose.

Abdomen: Tergite 2 yellow-brown, with black zones along anterior and posterior margins which do not extend dorsally; tergite 3 yellow to yellow-brown with narrow black anterior dorsolateral margin; tergite 7 mainly black to dark brown, grading yellow brown anteriorly and dorsally; tergite 8 black anteriorly, otherwise yellow-brown; remaining tergites yellow to yellow-brown. Sternite II mainly deep brown to black; sternites III to VI yellow to yellow-brown; sternite VII yellow to pale brown; sternite VIII pale brown.

Genitalia: Pygophore yellow-brown; upper lobes elongated laterally, relatively acutely

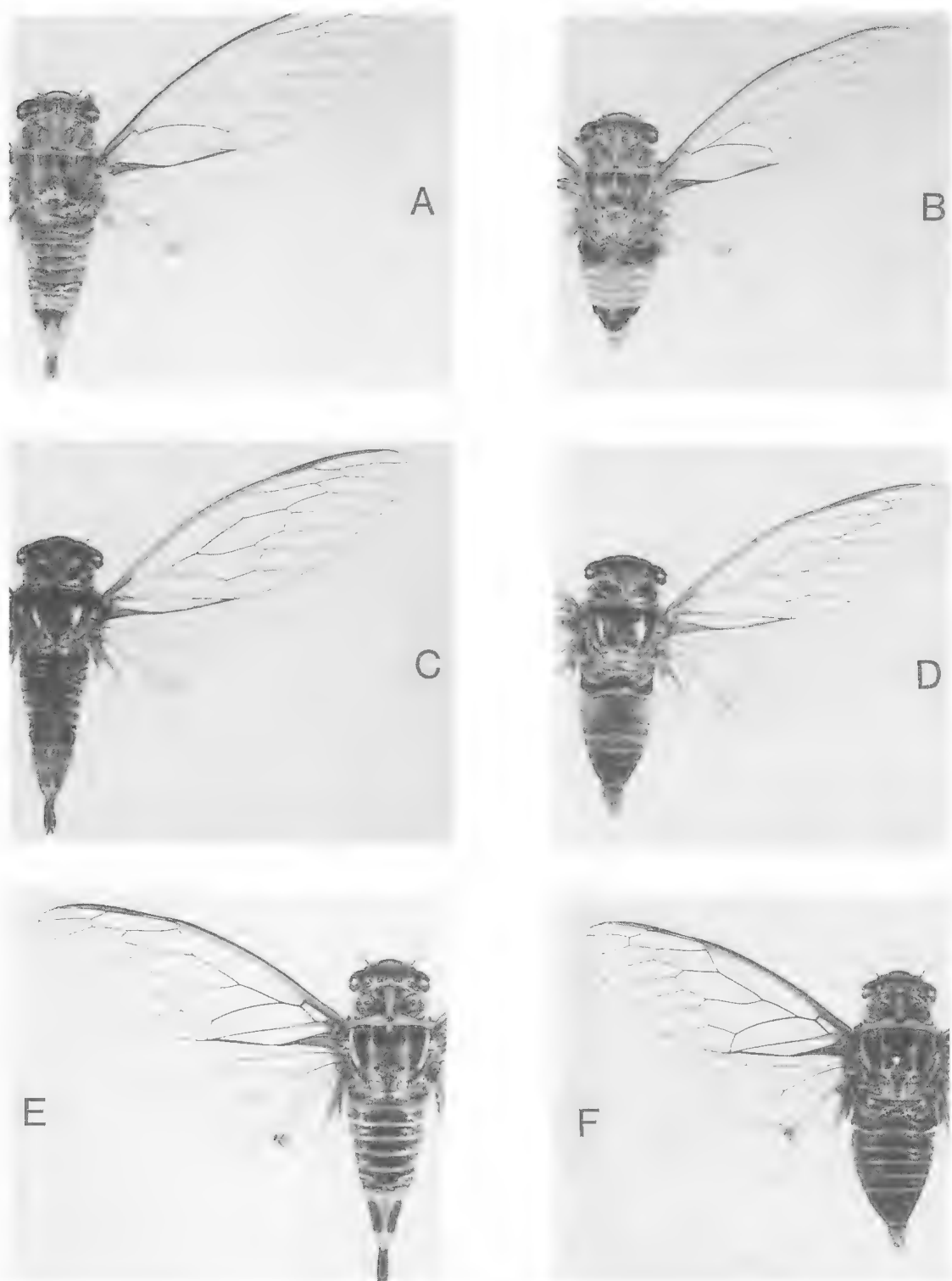


FIG. 8. A,B *P. elgneri* ♀, ♂. C,D *P. vitellinus* ♀, ♂. E,F *P. nigristriga* ♀, ♂. Each photograph x2 natural size.
Photographs: D.M. Reeves

terminated; prominent ascending claspers and ascending median process; curved pseudoparameres shorter than, and terminate dorsally to endotheca; endotheca with flanged and ornamented termination.

FEMALE: Markings and colouration similar to male, tending to brown rather than yellow colouration. Tergites 2 to 8 pale brown with irregular narrow black to dark brown dorsolateral anterior margins, extending laterally in tergite 7; yellow posterior margins to tergites 2-8; tergite 9 mainly pale brown to yellow-brown with a pair of black, clearly defined, anterior dorsolateral fasciae which narrow posteriorly and terminate approximately midway along length of tergite; antero-dorsal area of tergite 9 also dark brown; ovipositor sheath extends approximately 1.5 to 2 mm beyond tergite 9.

MEASUREMENTS: 12♂♂ and 11♀♀. Body length: ♂ 16.8-19.8 (17.87); ♀ 17.8-20.8 (19.26). Fore wing length: ♂ 22.4-25.4 (23.50); ♀ 23.9-26.4 (24.98). Head width: ♂ 5.5-6.4 (5.80); ♀ 5.6-6.5 (5.99). Pronotum width: ♂ 5.0-5.7 (5.25); ♀ 5.1-5.7 (5.39). Abdomen width: ♂ 5.6-6.2 (5.84); ♀ 5.0-5.7 (5.30).

DISTRIBUTION

Northeastern part of Cape York Peninsula, north of approximately Coen, to Cape York (Fig. 56). Occurs in paperbarks and eucalypts along river beds and banks (Moulds, in press).

COMMENTS

Closely resembles *P. melanopygia* and *P. extrema*, from which it is readily distinguished in male specimens by internal genital structures (Figs 5D, 6D, 7D) and the fused two dorsal tymbal ridges characteristic of *P. elgneri* (Fig. 7F). Females of *P. extrema* and *P. elgneri* are distinguished by tergite colouration (orange-brown on tergite 2 to 6, with 7 and 8 black in *P. extrema*; predominantly pale brown on tergites 2 to 8 in *P. elgneri*) and ovipositor sheath lengths (extending >1 mm and 1.5-2 mm beyond tergite 9, respectively). Females of *P. elgneri* and *P. melanopygia* are very similar, the latter differing in the more clearly defined anterior black colouration on tergite 8, orange colouration on sternite II (darker brown in *P. elgneri*), and the more clearly defined black marking on the mesonotum of *P. melanopygia*.

Paurosalta infrasila Moulds (Figs 4C, D, 9, 56)

Paurosalta infrasila Moulds, 1987:18-21, figs 2, 5, 6.

MATERIAL EXAMINED

HOLOTYPE: ♂ Isabella Falls, Bald Hill Stn (= Louisiana Stn) 30 km N of Cooktown, 13.ii.1982 M.S. and B.J. Moulds. (AM). Figured in Moulds (in press) Pl. IX, fig. 2.

PARATYPES: listed in Moulds (1987) from MSM, MV, JM, and AE collections.

OTHER MATERIAL: 4♂♂ from 23.46S 149.06E, 2 km S Horseshoe Lookout, Blackdown Tableland (JM).

DESCRIPTION

MALE: Head: Postclypeus shiny black to deep brown anteriorly with broad orange-brown margin extending inwards between transverse ridges; prominent yellow-brown area dorsally on midline; dorsal surface black around anterior margin and along midline, elsewhere orange-brown; silvery pubescence. Anteclypeus deep brown with silver pubescence. Rostrum pale brown distally, darker apically; extends to hind coxae. Gena and mandibular plate black with intervening suture brown; prominent silvery pubescence. Vertex lobes pale brown. Antennae medium brown. Ocelli pink to red. Eyes dark brown. Dorsal surface of head black with pale brown triangular area on longitudinal suture between ocelli; silver-yellow pubescence especially conspicuous behind eyes.

Thorax: Pronotum brown to orange-brown with broad pale sandy-brown central fascia bordered by sharply defined black rim which widens anteriorly and posteriorly; central fascia narrows and terminates before reaching pronotal collar; anterior margin and pronotal collar pale sandy-brown; irregular broken black markings between and adjacent to oblique fissures; sparse silvery pubescence.

Mesonotum with pair of pale sandy-brown dorsolateral fasciae which widen sharply inwards in median region, almost coalescing; pair of pale oblique broad lateral fasciae, extending into wing grooves, which coalesce with the dorsolateral fasciae near anterior arms of cruciform elevation; cruciform elevation pale yellow-brown, black anteriorly; remaining mesonotum black; margins of fasciae diffuse and irregular when viewed in detail; silver pubescence, especially along wing grooves.

Legs: Coxae dark to medium brown; fore and mid femora dark brown on anterior margins, longitudinal pale and darker brown fasciae on posterior margins; hind femora dark brown distally, paler apically; fore tibiae and tarsi brown; mid and hind tibiae and tarsi pale brown; claws and spines dark brown.

Wings: Hyaline; costal vein of fore wings reddish-brown; remaining venation of fore wings

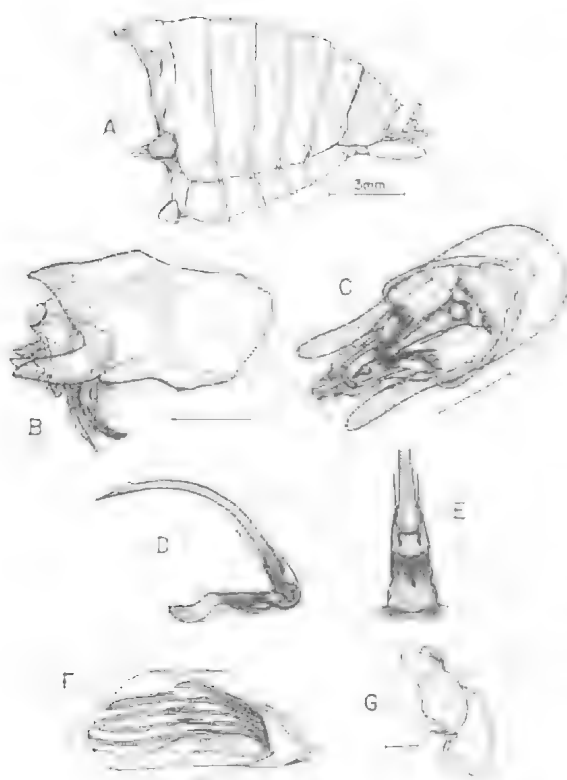


FIG. 9. *Pauropsalta infrasila* Moulds ♂. From specimen from Wrotham Park via Chillagoe, northern Queensland (JM collection). Symbols A to G, and scales, as in Fig. 2.

reddish-brown, becoming brown and darker towards apical cells and ambient vein; venation of hind wings brown. Hind wing infuscation spots faintly developed.

Tymbals: Lower third and fourth ridges joined anteriorly; dorsal ridge not extending across dorsal inter-ridge sclerite; distinct basal spur.

Opercula: Broadly sickle-shaped, relatively narrow, with narrow rounded inner termination; slight medial doming with shiny surface; declivous marginal flange especially developed around outer margin; medium to dark brown anteriorly, pale orange-brown to yellow-brown over posterior half; surface finely rugose.

Abdomen: Tergites 2 to 7 orange-brown with orange posterior margins; tergite 2 with anterior black margin extending around tergite (some specimens showing narrow dorsal discontinuity); tergites 3 to 7 with medium to deep brown median bands extending across dorsal surfaces, narrowing and terminating dorsolaterally; tergite 8 dominantly black to deep brown with anterior

and/or posterior irregular orange-brown margins. Sternite II mainly brown; sternites III to VIII orange-brown with orange posterior margins.

Genitalia: Pygophore brown anteriorly, pale brown over posterior half; upper lobes extended laterally, outwardly curved and somewhat spoon-shaped; prominent ascending and anteriorly curving, narrow claspers; inner and lower lobes not strongly bulbous; median process just visible when pygophore viewed laterally; lateral pair of small, fine, short pseudoparameres which join endothea close to gonocoxite IX; endothea curved with barb-like termination as seen in lateral perspective.

FEMALE: Basic markings and colouration as in male, there being some reduction in extent of darker colouration. Head: Upper surface of postclypeus largely pale brown; dorsal surface of head with additional pale dorsolateral areas adjacent to pronotum. Thorax: Mesonotum; dorsolateral pale brown fasciae are broader and coalesce anteriorly, thus producing two intervening distinct black obconical marks. Abdomen: Tergites dominantly brown to orange-brown dorsally, grading laterally to yellow-brown; brown dorso-anterior bands on tergites 3 to 8; tergite 9 with diffuse, broad, dorsolateral dark brown fasciae which extend laterally only three quarters of tergite length, otherwise tergite pale brown grading to yellow-brown posteriorly; ovipositor sheath extends approximately between 1-2 mm beyond tergite 9; sternites dominantly yellow-brown.

MEASUREMENTS: 25 ♂♂ and 21 ♀♀. Body length: ♂ 18.5-24.9 (21.41); ♀ 19.5-22.4 (20.79). Fore wing length: ♂ 22.4-29.5 (25.30); ♀ 23.4-26.2 (25.02). Head width: ♂ 5.7-7.1 (6.31); ♀ 5.8-6.7 (6.23). Pronotum width: ♂ 4.8-6.9 (5.6); ♀ 5.1-6.4 (5.63). Abdomen width: ♂ 5.6-7.1 (6.40); ♀ 5.1-6.1 (5.67).

DISTRIBUTION

Far northeastern Queensland, extending from 27 km E of Forsayth northwards through Chillagoe, the Atherton Tableland through Cooktown northwards to Iron Range, but also found near Weipa, Cape York Peninsula, and Blackdown Tableland, central Queensland (Fig. 56).

COMMENTS

This species is readily distinguished from *P. nigristriga* by the relative shapes of the upper lobes on the male pygophore (extended laterally and acutely terminated in *P. infrasila*, strongly curved 'hook-like' form in *P. nigristriga*), the absence of

black colouration on sternites II and VII in *P. infrasila*, and the relative lengths of the ovipositor sheath in females (extending beyond tergite 9 approximately 1-2 mm in *P. infrasila*; 2.5-3 mm in *P. nigristriga*). *P. infrasila* is closely similar to *P. opacus*, which also overlaps closely in range. These species are distinguished by male genitalia structures (Figs 9B-D, 10B-D), intensity of infuscation on hind wings (very weak in *P. infrasila*), and colouration of tergites (dominantly black to deep brown with pale brown to orange-brown posterior margins in *P. opacus*; predominantly orange-brown in *P. infrasila*).

***Paurosaltia opacus* n.sp.**
(Figs 4E,F, 10, 11, 56)

MATERIAL EXAMINED

HOLOTYPE: ♂ QUEENSLAND: Bakerville, Q, 11.xii.1972, J.H. Barrett (QM:Reg.No.T.11150).

PARATYPES: QUEENSLAND: 1♀, 1 mi. E of Bakerville, on trunk 'Bloodwood', 13.xi.1974, JDB; 1♂, Ewan Rd, 3-14 mi. W of Paluma, 4-6.i.1966, J.G. Brooks; 1♂ Mareeba, 4.iii.1981, J.T. Moss; 1♂ (damaged), 1♀, Mt Molloy, nr Mareeba, 10.ii.1973, J.T. Moss; 1♂, Paluma, 23.xi.1981, T. Hawkeswood, Dept Forest. Qd Acc. 5248; 2♀♀, Station Ck, nr Mt Carbine, 4.iii.1981, J.T. Moss (JM). 1♀, Clohesy R., 17.i.1974, A. and M. Walford-Huggins; 1♀, Davies Ck Falls, nr Mareeba, 21.i.1982, G. and A. Daniels; 1♀, 10 km E of Davies Ck N.P., nr Mareeba, 550 m, eucalypt woodland, 10.i.1980, A. Hiller; 1♂, Irvinebank, W of Herberton, 29.xii.1982, G. Wood; 1♂, Mareeba, 3.ii.1974, A. and M. Walford-Huggins; 1♂, 1♀, Station Ck, S of Mt Carbine, 27.xi.1979, M.S. and B.J. Moulds; 1♂, Tinaroo Ck Road, nr Mareeba 21.i.1982, G. and A. Daniels, Eucalypt-Casuarina; 1♂, Tinaroo Dam, nr Atherton, 20.xii.1981, J. Olive; 4♂♂, 2♀♀, Tinaroo Lakes, 20.xii.1981, J. Olive; 1♂, Walsh Bluff, 17 km NW Atherton, 30.xi.1986, D.A. Lane; 1♂, Walsh's Pyramid nr Gordonvale, 18.ii.1983, G. Wood (MSM).

ETYMOLOGY

Latin for shady or dim, which refers to general dull appearance of this insect.

DESCRIPTION

MALE: Head: Predominantly black. Postclypeus shiny black anteriorly with pale brown margin, extending slightly between transverse ridges; conspicuous pale brown area dorsally on midline; dorsal surface pale brown; silver-gold pubescence. Vertex lobes pale brown. Anteclypeus shiny black with conspicuous silver pubescence. Rostrum brown, darker apically; extends to hind coxae. Gena and mandibular plate black with narrow marginal pale brown ridge and conspicuous silvery

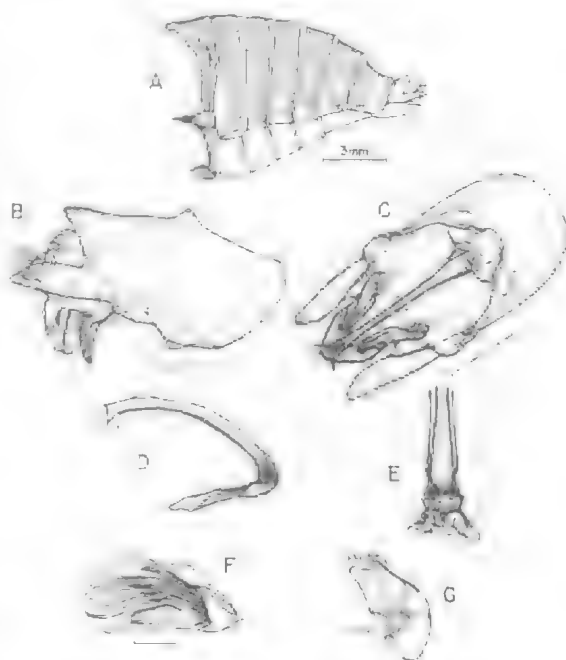


FIG. 10. *Paurosaltia opacus* sp.n., ♂, based on specimen from Ewan Rd, West of Paluma, northern Queensland. Symbols A to G, and scales, as in Fig. 2.

pubescence. Antennae medium brown. Ocelli pink to pale red. Eyes brown. Dorsal surface of head black with triangular pale brown depressed area situated on longitudinal suture between ocelli; two pairs of additional, small pale areas between lateral ocelli and eyes; silvery-gold pubescence.

Thorax: Pronotum dominantly brown with pale brown, spindle-shaped central fascia, not extending to pronotal collar, and enclosed by narrow black envelope; discontinuous black areas adjacent to, and between oblique fissures; pronotal collar pale brown; silvery-gold pubescence.

Mesonotum black with brown dorsolateral fasciae which broaden and join dorsally, extending to cruciform elevation; a pair of oblique broad lateral fasciae which coalesce with the dorsolateral fasciae adjacent to cruciform elevation; cruciform elevation brown; silvery-gold pubescence especially laterally.

Legs: Coxae dark brown; femora dark brown with two broad pale brown longitudinal fasciae on outer margins; fore tibiae brown, mid and hind tibiae paler brown; fore tarsi brown, mid and hind tarsi sandy brown; claws and spines dark brown.

Wings: Hyaline; fore wing venation pale to medium brown, darker towards apical cells; hind wing infuscation spots small but conspicuous.

Tymbals: Dorsal ridge not extending across dorsal inter-ridge sclerite; indistinct basal spur.

Opercula: Relatively narrow, gently undulate, roughly sickle shaped; narrow rounded inward (posterior) terminations, with gentle median dome; shiny and mostly dark brown in anterior and median areas; posterior region pale sandy brown; declivous narrow flange around complete outer margin; surface finely rugose.

Abdomen: Tergite 2 mostly black, in some specimens with narrow reddish-brown zone adjacent to posterior margin; tergites 3 to 7 most commonly black to dark brown becoming pale brown to reddish-brown along lower lateral margins, although sometimes the paler colouration extends upwards along anterior and posterior margins of each tergite; tergite 8 with broad irregular anterior dark band, otherwise pale brown; posterior margins to tergites pale brown to orange-brown. Sternite II mostly black to deep brown with narrow pale brown zone; sternites III to VIII orange-brown; posterior margins of sternites yellow-brown.

Genitalia: Pygophore brown; upper lobes elongated laterally, somewhat spoon-shaped, and relatively acutely terminated; elongated ascending claspers, grooved and gently hooked apically; lower and inner lobes conspicuously bulbous; median process conspicuous and ascending; aedeagus with lateral, relatively short, and very thin pseudoparameres, each with small clavate terminations; endotheca cylindrical, curved, with distinctive tripartite, plate-like termination.

FEMALE: Markings and colouration similar to male. Tergites 2 to 7 mainly black with brown lower areas extending upwards along posterior margins of each tergite; tergite 8 black along anterior margin, but with broad pale brown posterior margin; tergite 9 brown, paler posteriorly, with pair of dorsolateral black fasciae extending laterally and coalescing dorsally at posterior termination of tergite; ovipositor sheath extends between 1-2 mm beyond tergite 9. Sternites III to VI medium brown with orange-brown posterior margins; sternite VII medium brown with black median patches adjacent to ovipositor.

MEASUREMENTS: 14♂♂ and 8♀♀. Body length: ♂ 20.1-22.6 (21.83); ♀ 20.3-26.4 (23.56). Fore wing length: ♂ 24.4-29.2 (26.47); ♀ 25.2-29.2 (27.08). Head width: ♂ 6.1-7.1 (6.39); ♀ 5.8-7.1 (6.57). Pronotum width: ♂ 5.6-6.6 (6.02); ♀ 5.6-6.6 (6.05). Abdomen width: ♂ 6.1-7.0 (6.54); ♀ 5.6-6.6 (6.22).



Fig. 11. Oscillograms of calling song of *P. opacus*, recorded from Mareeba (JM). Records A and B, recorded at the same time scales, show the two song phases. The expanded time scale records (C,D) illustrate the pulse structures of each phase in more detail.

DISTRIBUTION

Atherton Tableland region, from the Herberton area to near Mt Carbine; there is a single specimen from Paluma, north of Townsville (Fig. 56).

COMMENTS

This species is morphologically very close to *P. infrasila*. Distinguishing characteristics are given under *P. infrasila*.

SONG

Consists of two distinct phases (Fig. 11), emitted alternately without pause. The two phases comprise a low frequency song, lasting some 8-9 sec in the available recording, alternating with a higher frequency phase, lasting some 4-5 sec, which exhibits an initial increasing amplitude and a relatively sharp finish. The frequency of the pulse groups constituting the low frequency song are 15-17 Hz, whilst the frequency of the second song phase is estimated to be 195-205 Hz (including both the low and high amplitude pulses), or 98-103 Hz (frequency of higher amplitude pulses only). Both song phases have markedly bimodal pulse amplitudes.

The pulse groups of the low frequency phase comprise four distinct pulses, the second being of higher amplitude; each pulse group is emitted over an interval of approximately 14 msec, with intervals of 5 to 6, 2 to 3, 5 to 6 msec between the four pulses (i.e. the interval between pulses 2 and 3 is shortest).

The pulses of the fast song phase exhibit an alternating sequence of high and low amplitude pulses, virtually evenly spaced, with intervals of approximately 10 msec between the emission of each high amplitude pulse, and approximately 5 msec between each individual pulse.

P. MARGINATA SPECIES-GROUP

This species-group of ten species is the largest within *Pauropsalta* in Queensland. They are all small to small-medium sized (13-19 mm, ♂ body length), and include the majority of the small dark grey to black *Pauropsalta* (previously loosely grouped under the name *P. encaustica*). All species occur in open forest country, are fast flying, and well camouflaged at rest (especially when on tree trunks and major branches, their favoured environments). They occur most extensively through eastern New South Wales and Queensland, on or east of the Dividing Range, with the exceptions of *P. siccanus* and *P. virgulatus*. The male genitalia morphology

suggests that the *P. marginata* group is most closely allied to the *P. annulata* species-group.

Pauropsalta encaustica (Germar)

(Figs 12-15)

Cicada encaustica Germar, 1834:62; Walker, 1850:174; Dohrn, 1859:74.

Cicada arclus Walker, 1850:184; Dohrn, 1859:74; synonymized by Stål, 1862:482,484.

Cicada juvenis Walker, 1850:188; Dohrn, 1859:74; synonymized by Stål, 1862:482.

Melampsalta encaustica (Germar) Stål, 1861:619; Froggatt, 1896:531; Froggatt, 1903:420; Kato, 1932:187; Burns, 1957:651; Greenup, 1966:62-63; Nikitin, 1971:23.

Melampsalta arclus (Walker) synonymised by Stål, 1862:484.

Pauropsalta encaustica (Germar) Goding and Froggatt, 1904:565; Distant, 1906:178; Froggatt, 1907:354; Kirkaldy, 1907:309; Ashton, 1912b:27; Ashton, 1912c:80; Ashton, 1914:355; Hardy, 1918:71; Haupt, 1918:87; Tillyard, 1926:161; McKeown, 1944:234,237; Tiegs, 1955:302-303, Pl. 26, figs 166-169; Metcalf, 1963:406-407; Dugdale, 1972:879; Duffels and van der Laan, 1985:301.

Pauropsalta arclus (Walker) Goding and Froggatt, 1904:565.

MATERIAL EXAMINED

LECTOTYPE: ♂ of *Cicada encaustica*, here designated, in HEC (Hem. Type 785 1/3); 'N.H.' (= New Holland; small white label, written in ink); 'Melampsalta encaustica Germ Named in British Museum by W.W. Fowler 1896. Moreton Bay Australia etc. Distribution]. of sp. in B.M.'.

HOLOTYPE: ♂ of *Cicada arclus* (Fig. 13) in BMNH; three labels on specimen as follows: Green rimmed Type label; '133. *Cicada arclus*' (printed); 'Ent. Club. 44-12'. Reference to the BMNH accession catalogue indicates that the number 44-12 refers to 1844, item 12, which details various insect groups (including 100 Homoptera) presented by the Entomological Club. No locality data are given.

HOLOTYPE: ♂ of *Cicada juvenis* (Fig. 13) in BMNH; three labels on specimen as follows: Green rimmed Type label; '138. *Cicada juvenis*' (printed); '44 105' (one side of small white label), 'N.H. Pt. Steph' (reverse side of label). Reference to BMNH accession catalogue indicates that 44 105 refers to 1844, item 105, comprising 19 Homoptera (plus other insect groups), presented by the Earl of Derby, collected by Macgillivray. The label abbreviations N.H. and Pt. Steph refer to New Holland and Port Stephens, respectively.

OTHER MATERIAL: 19♂♂, 3♀♀ from following localities. NEW SOUTH WALES: Bells Line Rd, nr Mt Wilson turnoff, Blue Mts; Glenbrook; Loftus (nr Royal National Park); Mt Westmacot, W of Royal National Park; Sutherland, nr Royal National Park; Warragamba Dam; Water Fall (Royal National Park) (JM). Stanwell Park (AE).

DESCRIPTION

MALE: Head: Postclypeus; shiny black anteriorly with well defined pale red-brown margin and small spot dorsally on midline; dorsally black; silver-yellow pubescence. Anteclypeus black. Rostrum pale distally, becoming dark brown-black apically; extends to mid coxae. Gena and mandibular plate black, with pale marginal ridge and intervening suture; silvery pubescence. Antennae black. Ocelli pink. Eyes brown. Vertex lobes red. Dorsal surface of head black with pale triangular area on longitudinal suture between ocelli; short yellowish pubescence.

Thorax: Pronotum black with brown anterior margin and pronotal collar, and narrow brown central fascia not reaching margin of pronotum; short yellowish pubescence.

Mesonotum dominantly black with reddish-brown dorsolateral fasciae, widening inwards (dorsally), and extending to anterior arms of cruciform elevation, which is also reddish brown; wing grooves red-brown to pale brown, with conspicuous adjacent pale pubescence.

Legs: Coxae black, with reddish-brown margins on fore coxae; fore femora black, grading to brown (hind femora), with longitudinal red-brown fasciae on fore femora, and pale red-brown terminations on mid and hind femora; tibiae, tarsi, and claws brown, become paler on hind legs.

Wings: Venation brown, becoming darker around apical cells and ambient vein. Hind wing infuscation spots distinct.

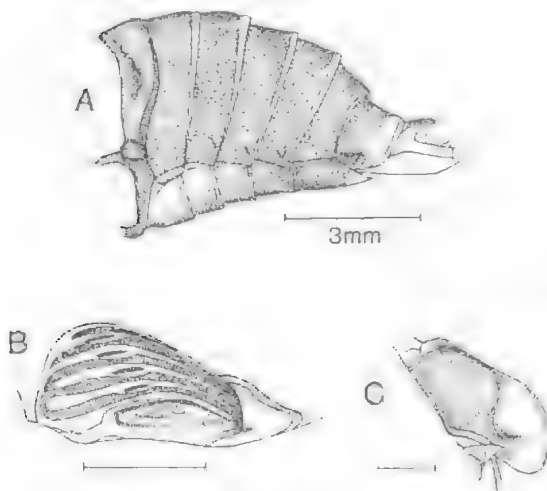


FIG. 12. *Pauropsalta encrustica* (Germ.), lectotype, ♂, in HEC. A: Abdomen, viewed laterally from left side. B: Left tymbal. C: Left opercula.

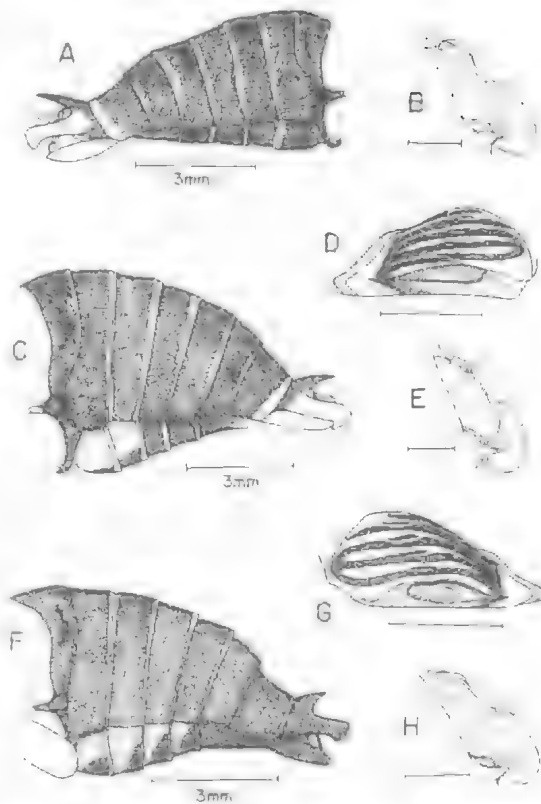


FIG. 13. A,B: *Cicada arclus* Walker: Holotype, ♂, BMNH, showing abdomen and opercula. C-E *Cicada juvenis* Walker: Holotype, ♂, BMNH, showing abdomen, tymbal, and opercula. F-H: *Pauropsalta dolens* (Walker): Holotype, ♂, BMNH, showing abdomen, tymbal, and opercula. Scales represent 1 mm, except where otherwise indicated.

Tymbals: Dorsal ridge extends across dorsal inter-ridge sclerite; the two (in some specimens, three) lower ridges joined anteriorly; indistinct basal spur.

Opercula: Roughly sickle-shaped, broadly undulate, but not domed; black anteriorly, pallid around outer margin and posteriorly; declivous outer flange; inner (posterior) termination rounded; surface finely rugose.

Abdomen: Tergites dominantly black, with pale yellow-brown posterior margins; tergites 7 and 8 have paler yellow-brown posterior margins, which narrow dorsally; in some specimens, tergites 2 to 6 have narrow irregular dorsolateral red-brown zones adjacent to posterior margins. Sternites II to VII dominantly deep brown to black, with paler dorsolateral area on sternite III, and pale brown

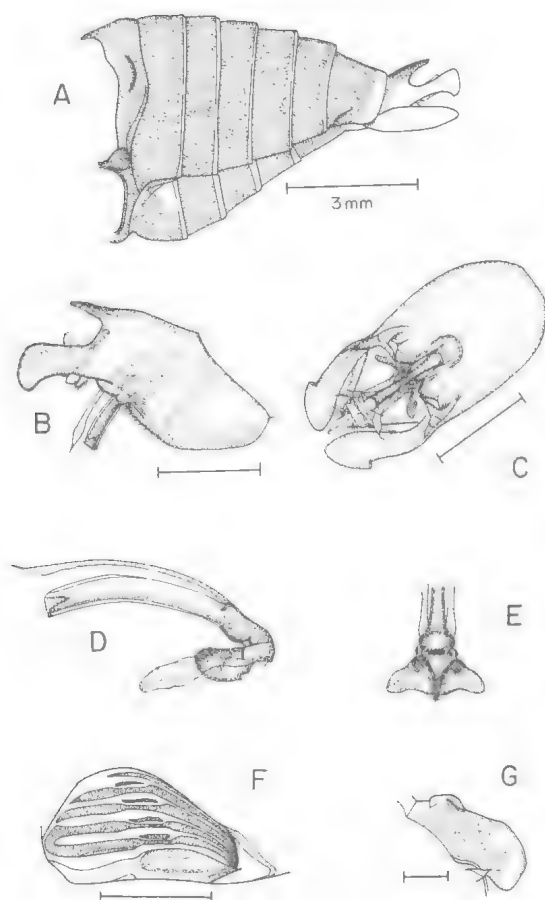


FIG. 14. *Pauropsalta encaustica* (Germar) ♂, based on specimen from Loftus, near Royal National Park, Sydney (JM). Symbols A to G, and scales, as in Fig. 2.

near posterior margin on sternite VII; sternite VIII pale reddish-brown; posterior margins of sternites pale yellow-brown.

Genitalia: Pygophore black dorsally, otherwise pale brown, with the pale brown to pallid, sub-ascending and hooked upper lobes especially prominent. Aedeagus with dorsal pseudoparameres slightly longer than endotheca; endotheca cylindrical, curved, with apical pair of lateral wing-like processes which taper towards base.

FEMALE: Colouration and markings closely similar to male, with slight overall increase in extent of paler areas of colouration. Central fascia on pronotum more prominent; dorsolateral red-brown fasciae on mesonotum more extensive centrally. Legs: Femora, tibiae, and tarsi paler than in male, with distinct brown longitudinal

fasciae on femora, which are broadest on fore femora. Abdomen: Tergites 2 to 8 dominantly black, with more clearly developed red-brown zone adjacent to posterior margins, narrowing dorsally; tergite 9 black dorsally and anterio-dorsally, otherwise pale brown with near central black spot; ovipositor sheath extends only to termination of tergite 9, or very slightly beyond. Sternites black on median and anterio-median areas, otherwise pale yellow-brown.

MEASUREMENTS: 19♂♂ and 3♀♀. Body length: ♂ 13.5-16.3 (14.52); ♀ 14.5-16.3 (15.32). Fore wing length: ♂ 14.7-18.3 (16.79); ♀ 15.7-19.3 (17.61). Head width: ♂ 4.2-5.0 (4.66); ♀ 4.6-5.3 (4.98). Pronotum width: ♂ 3.5-4.2 (3.91); ♀ 3.8-4.3 (4.13). Abdomen width: ♂ 3.8-4.6 (4.20); ♀ 3.7-4.6 (4.23).

DISTRIBUTION

The Sydney region, especially the Hawkesbury Sandstone area, extending north to Port Stephens.

COMMENTS

Two syntypes are identified at HEC (Ewart, in press). The male (Fig. 12) with the Fowler label is selected as lectotype and has been labelled as such. The reference to Moreton Bay on the Fowler label, however, is considered erroneous. The upper pygophore lobes and beak are slightly damaged. A second paralectotype, conspecific with the lectotype, has a single white label: 'VDL' (handwritten in black ink).

Cicada arclus Walker, *C. juvenis* Walker, and *C. dolens* Walker were synonymized by Stål (1862:482,484) with *C. encaustica* Germar and this decision was followed by subsequent workers (e.g. Goding and Froggatt, 1904; Distant, 1906b; Metcalf, 1963; Duffels and van der Laan, 1985). The holotype ♂ of *Cicada dolens* (Fig. 13) is also held in BMNH, and bears the following three labels: Green rimmed Type label; '140 *Cicada dolens*' (printed); '40 12.16 257.' (handwritten on small white label). These numbers refer to the acquisition date (16th of 12th month, 1840), Item 257. The BMNH accession catalogue show it to come from New Holland, King Georges Sound, presented by Capt Grey. (Examined).

Examination of the types (Figs 12-13) of *Cicada encaustica* Germar, *C. arclus* Walker, and *C. juvenis* Walker indicates that they are conspecific. *Cicada dolens* Walker, however, is not conspecific with *C. encaustica* Germar (Figs 12,13), and is listed in this work as a valid species. It is not described in detail as the type locality is SW Australia.

P. encaustica is very close morphologically to

P. fuscata. The males are readily distinguished by the colouration of the upper lobes of pygophore, which are pallid to pale brown in *P. encaustica* and black in *P. fuscata*; song patterns are characteristic (Figs 15,23). Females are especially difficult to distinguish morphologically, only the slightly more extensive blacker colouration on tergite 9, the larger size, and the more conspicuously red-brown coloured zones adjacent to posterior margins along tergites 2-8 in specimens of *P. encaustica* are useful, but not wholly diagnostic criteria.

SONG

Oscillograms are shown for two individual Sydney insects, at low film speeds (i.e. low resolution), based on tapes provided by Dr. J. Moss (Fig. 15). The two songs differ slightly, one (A) consisting of discrete groups of pulses (phrases), the second (B) an essentially continuous train of pulses. The pulse repetition frequency is similar in both, between 11.3-12.9 Hz in A, and 10.3-10.5 Hz in B. In the song shown in Fig. 15A, the phrases consist of between 7 to 13 pulses, with intervals of between 0.4-0.5 sec between phrases, each of these interphrase intervals being characterised, nearly midway between each interval, by the emission of a group of 3 to 4 very closely spaced, overlapping pulses. Although the oscillograms (Fig. 15) cannot be closely resolved, it is evident that each pulse that makes up the main unit of the song patterns constitutes a more complex pulse group.

Paurosalta corticinus n.sp. (Figs 16,17,18A,B,57)

Paurosalta species A Ewart, 1986: 51-54, fig. 3A.

MATERIAL EXAMINED

HOLOTYPE: ♂ QUEENSLAND: Beerburum, c. 60 km N of Brisbane, 17.ii.1978, song recorded, A. Ewart (QM; Reg. No. T.9185).

PARATYPES: QUEENSLAND: 2♀♀, Ban Ban Range via Coalstoun Lakes, 5.ii.1975, H. Frauca; 1♂, Biggenden, Bluff Range foothills, 1-7.i.1972, H. Frauca; 1♂, Brisbane, W.W. Froggatt Collection; 1♂, Mt Walsh N.P., 7 km SE of Biggenden, 17.ii.1978, H. Frauca; 2♀♀, 27.33S 151.59E, Prince Henry Heights, 620m, Toowoomba, 7.i.1983, I.F.B. Common, 2♂♂, 10.i.1983 (ANIC); 1♂, 1♀ Doolandella, Brisbane, 12.xii.1981, to light (BMNH). 1♂, Doolandella, Brisbane, 9.x.1983, A.E., 1♀, at light, 11.xii.1981 (MNDN); 1♀, Brisbane, 26.xii.1927, A.N. Burns; 1♂, Brisbane, 5.i.1928, A.N. Burns; 1♂, Brisbane, 11.iii.1930, A.N. Burns; 1♂, Brisbane, 7.xi.1951, R. Dobson; 4♂♂, 3♀♀, Brisbane, 8.ii.1954; 1♂, Brisbane, 9.iii.1954, J. Kerr; 2♂♂,

4.0 sec

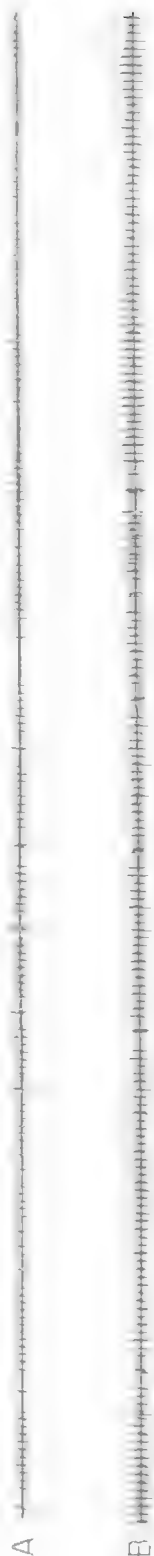


FIG. 15. Oscillograms of two sets of calling songs of *P. encaustica*, recorded at Sutherland and Loftus, Sydney (JM)

Brisbane, 17.x.1954, J. Kerr; 8♂♂, 2♀♀, Brisbane, 27.xi.1955, J. Kerr; 1♂, Brisbane, 13.iii.1955, J. Kerr; 1♂, Brisbane, 21.i.1956, J. Kerr; 1♂, Brisbane, 26.xii.1956, J. Kerr; 1♂, Brisbane 28.xii.1956, J. Kerr; 1♂, 2♀♀, Brisbane, 15.i.1957, J. Kerr; 1♀, Brisbane, 16.i.1957, J. Kerr; 3♀♀, Brisbane, 2.ii.1957, J. Kerr; 2♀♀, Brisbane, 15.i.1959, J. Kerr; 1♂, 1♀, Brisbane, 1.i.1959, JK; 2♂♂, 1♀, Brisbane, 27.xii.1959, J.K.; 1♀, Brisbane, 9.i.1960, J.K.; 1♂, Brisbane, 2.i.61, JK; 1♂, 1♀, Brisbane, 26.xii.1961, JK; 1♀, Burleigh Heads, 3-4.i.1956, J. Kerr; 1♂, Caloundra, xi.1959, JK; 2♂♂, Coolum, iii.1954, GL; 1♂, Glen Aplin, 28.x.1945, A.G.; 2♂♂, 2♀♀, Mt Cooth-tha, 14.xi.1954, J. Kerr; 1♀, Mt Cooth-tha, 12.iii.1955, J. Kerr; 1♂, Mt Emlyn, 3.xii.1955, J. Kerr; 1♀, Mt Glorious, 3.i.1960, J.K.; 1♂, Mt Tamborine, i.1958, C. King; 1♀, Noosa Hds., 6.x.1955, AB; 1♂, Palmwoods, 24.ix.1955, AB; 1♂, Stanthorpe, 15.i.1957, J. Kerr (MV). 2♂♂, 1♀, Brisbane, 20.xi.1911, H. Hacker; 1♂ Brisbane, 27.xi.1911, H. Hacker; 3♂♂, Brisbane, 16.xi.1912, H. Hacker; 3♂♂, Brisbane, 3.ii.1913, H. Hacker; 1♂, Brisbane, 14.x.1913, H. Hacker; 1♂, 1♀, Brisbane, 15.ii.1916, H. Hacker; 1♂, Brisbane, 16.x.1921, H. Hacker; 2♂♂, Brisbane, 7.xi.1921, H. Hacker; 1♂, Brisbane, 16.x.1923, H. Hacker; 2♀♀, Brisbane, 23.x.1969, J.L. Wilson; 1♂, Brisbane, 26.xi.1969, A. Hiller; 1♀, Kilcoy, 18.ii.1954, S. Gunn; 1♀, Stradbroke Is., 3.xii.1912, H. Hacker (QM). 1♂, 1♀, Amiens S.F. nr Stanthorpe, 22.xi.1980, G. Daniels and M.A. Schneider, 2♂♂, 24-26.xi.1981; 1♂, Gatton, 3.iv.1956, C.A. Muir; 1♂, Mt Marley, nr Stanthorpe, 26.xi.1981, G. Daniels and M.A. Schneider; 1♂, Planted Ck, via Tansey, 12.xii.1976, G.B. and S.R. Monteith; 1♂, Stanthorpe, 27.i.1927; 1♂, Tamborine Mt, C. Deane; 1♂, Towba (= Toowoomba), 9.ii.1920, J.A. Beck (UQIC). 2♂♂, 1♀, Booyal nr Childers, 1.ii.1973, J.T. Moss; 1♂, 3♀♀, Borumba Dam nr Imbil, 26.i.1980, J.T. Moss; 1♀, Brookfield, Brisbane, 8.i.1973, J.T. Moss; 2♂♂, 1♀, Hervey Bay, 24.x.1982, J.T. Moss; 6♂♂, 3♀♀, Leslie Dam via Warwick, 18.xi.1984, J.T. Moss; 2♂♂, Mt Morgan, 16 km E, 1.i.1973, J.T. Moss; 1♂, Mt Walsh N.P., nr Biggenden, 19.ii.1979, J.T. Moss; 1♀, 28.14S 153.08E c. 1 km W of O'Reilly's, Lamington N.P., 6.xi.1971, C.H.L. Key; 2♂♂, 1♀, Somerset Dam, nr Kilcoy, 30.xii.1973, J.T. Moss; 1♂, Somerset Dam nr Kilcoy, xii.1983, J.T. Moss; 1♂, Stanthorpe, 24-25.xii.1983, J.T. Moss; 4♂♂, 4♀♀, Widgee Ck on Burnett Hwy nr Gympie, 2.xii.1981, J.T. Moss; 2♂♂, Woolooga nr Gympie, 20.ii.1973, J.T. Moss; 1♂, Yandina, via Nambour, 3.i.1974, J.T. Moss (JM). 1♂, Amiens, 1.xii.1985, R. Eastwood; 1♂, Mt Beerburum, 6.xii.1985, R. Eastwood; 1♀, Beerwah, 24.i.1986, R. Eastwood; 2♂♂, 1♀, Boreen Pt, Cooloolo, 9.xi.1980, R. Eastwood; 3♂♂, Caloundra, 15.xi.1978, R. Eastwood; 1♂, Camira, Brisbane, 7.ix.1983, J.T. North; 1♂, Carindale, 26.ix.1984, B. Montgomery; 1♂, Coolum Heights, 21.x.1986, R. Eastwood; 1♂, 1♀, Doolandella, Brisbane, 12.xii.1981, A. Ewart; 1♂, Elanda Pt, L. Cootharaba, 26°14'S 153°00'E, 2.ii.1986, G. and A. Daniels; 3♂♂, 5♀♀, Elanda Pt to Kin Kin Ck, 26°14'S 153°00'E, 17.xi.1985, G. and A. Daniels; 1♂, Fairlies Knob, 57Km W Maryborough, 24.i.1987, R. Eastwood; 1♂, The Gap, 28.ix.1980, P. Herbert; 1♂,

Goomburra S.F., 35 km E of Allora, 21.xii.1981, coll. unknown; 1♂, 4♀♀, c. 16 km S Gympie, 3.ii.1973, A. and M. Walford-Huggins; 1♂, Hodgson Vale, nr Toowoomba, 15.iii.1981, J. North; 1♀, Jamboree Heights nr Brisbane, 14.x.1979, G. Daniels; 1♂, Jimna, N of Kilcoy, 17.xii.1979, A. Hiller; 2♂♂, 2♀♀, Kinbombi Falls nr Goomeri, 19.xii.1976, M.S. and B.J. Moulds; 1♂, Kroombit Tops, N of Monto, 14.x.1983, G. Theischinger; 1♂, Leyburn, 27.i.1985, C.E. Hagan; 1♀, Maroochydore, 1.ii.1986, R. Eastwood; 1♀, Mt Cooth-tha, nr Brisbane, 3.i.1977, G. Daniels; 1♂, Mt Glorious, 635 m, rainforest, 22 km NW Brisbane, xii.1982, Anthony Hiller; 2♂♂, Mt Marlay, Stanthorpe, 4.ii.1984, G. and A. Daniels; 2♂♂, Mt Marlay, Stanthorpe, 22.xii.1986, R. Eastwood; 3♀♀, Mt Moffat N.P., Kenniff's Lookout, 13.xii.1987, Monteith, Thompson, and Yeates; 2♂♂, 2♀♀, Mt Moffat N.P., Mahogany Forest, 1000 m, 11-12.xii.1987, Monteith, Thompson, and Yeates; 10♂♂, 6♀♀, Mt Moffat N.P., Top Shelter

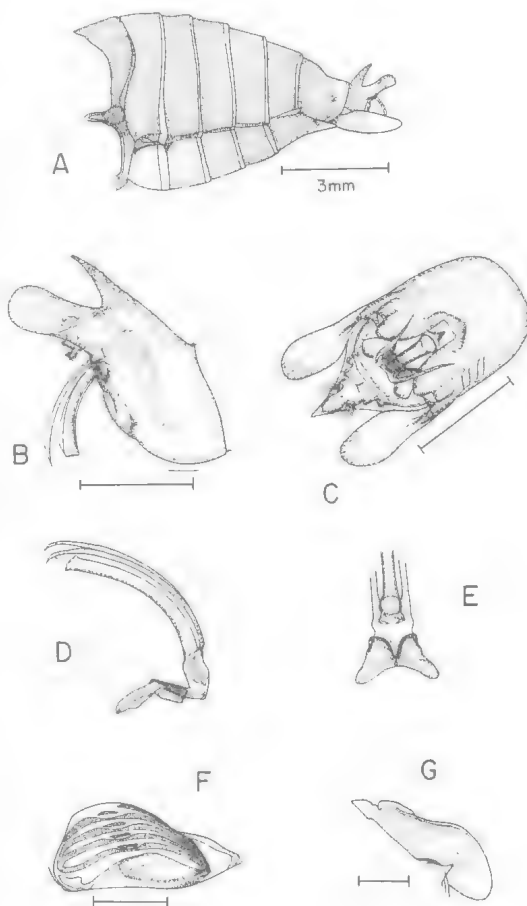


FIG. 16. *Pauropsalta corticinus* sp.n., ♂, based on specimens from southwestern Brisbane and the Bunya Mts, southern Queensland. Symbols A to G, and scales, as in Fig. 2.

Shed, 1000 m, 10-12.xii.1987, Monteith, Thompson, and Yeates; 1♂, Mt Moffat N.P., Top Moffat Camp, 13-15.xii.1987, Monteith, Thompson, and Yeates; 1♂, Mt Tibberoowuccum, Glasshouse Mts, 12.ii.1984, open eucalypt forest, C.E. Hagan; 1♂, Nambour, 3.i.1978, R. Eastwood; 1♂, 1♀, Noosaville, 26.x.1984, R. Eastwood; 1♂, Redcliffe, Brisbane, 15.x.1983, J. North; 1♂, Saltwater Ck, Maryborough, 22.xi.1986, R. Eastwood; 1♂, St Lucia, 10.x.1980, R. Monks; 1♂, St Lucia, Brisbane, 20.x.1983, J. North; 1♂, St Lucia, Brisbane, 17.x.1985, C. Peart; 1♀, Tallebudgera Ck, 15-20 km SSW of Burleigh Heads, 19.x.1980, D.J. Cook; 1♂, Toowong, 2.xi.1982, J. North; 2♂♂, Toowoomba, 8.xii.1979, M.S. and B.J. Moulds; 1♂, 1♀, Toowoomba, 20.xii.1984, I.F.B. Common; 1♀, Ugly Gully, nr Mt Crosby, 13.iii.1981, G. Daniels; 1♂, Wallangarra, nr New South Wales border, 23.iv.1978, M.S. and B.J. Moulds; 4♂♂, Warwick, 18.xi.1962, M.S. Moulds; 1♂, West Coolumb, 11.xii.1986, R. Eastwood; 3♂♂, 1♀, Yelarbon, 11.xi.1973, M.S. Moulds (MSM). 1♂, Agnes Waters, 5.ii.1984, A.E.; 1♂, Allawah, Mt Crosby, 30.xi.1975, A.E.; 1♀, Beerburrum, 17.ii.1978, A.E.; 1♂, Boonah Rd turnoff, W Ipswich, 2.xi.1980, A.E.; 2♂♂, Brisbane Forest Park, xi.1982, R. Leggatt; 1♂, Brookfield, i.xii.1975, A.E.; 3♂♂, 1♀, Bunya Mts, 16.xii.1976, A.E.; 1♂, 1♀, Burnett Ck, Mt Maroon, 16.xi.1975, A.E.; 1♂, Cambells Folly (Mt Lindsay), 12.xi.1971, A.E.; 6♂♂, 1♀, Carnarvon Lodge, Carnarvon N.P., 8-12.xii.1985, J.T. Moss and A.E.; Doollandella, Brisbane, A.E., as follows, 1♂, 18.x.1981; 2♂♂, 1♀, 12.xii.1981; 1♂, 1♀, 9.ii.1982; 2♂♂, 17.ii.1982; 1♂, 14.iii.1982; 1♂, 11.ii.1983; 1♂, 1♀, 13.ii.1983; 1♂, 14.x.1983; 4♂♂, 9.xi.1983; 5♂♂, 4♀♀, 'Iron Bark', Crows Nest, 22.xi.1975, A.E.; 1♂, Ivory Rk, S of Ipswich, 29.i.1972, A.E.; 2♂♂, 4♀♀, Jacobs Well, 3.iii.1978, A.E.; 2♂♂, Jacobs Well, 7.iii.1978, A.E.; 7♂♂, Kroombit Tops, Forestry Barracks, 12.xii.1983, A.E.; 2♀♀, Kroombit Tops, Kroombit Ck, 16.xii.1983, A.E.; 10♂♂, 7♀♀, Kroombit Tops, northern escarpment, 16.xii.1983, A.E.; 1♂, 1♀, Kroombit Tops, Lower Ck, TA47, 17.xii.1983, A.E.; 1♂, 1♀, Base of Mt Coolumb, 17.x.1981, A.E.; 2♂♂, Mt Crosby, 8.iii.1981, A.E.; 1♂, Pt Elanda, L. Cootharaba, 15.xii.1978, A.E.; 1♂, 17.xii.1978; 1♂, Samford (S.F.), 6.xii.1975, A.E.; 1♂, Swanbank, nr Ipswich, 23.ix.1978, A.E.; 1♂, Tarragindi, 3.iii.1978, D. Reeves, 1♂, 7.x.1978, D. Reeves, 1♀, 19.xii.1978, 1♂, 24.ii.1979, 1♂, 12.xii.1980 (AE). NEW SOUTH WALES: 1♂, Tenterfield, 1906, W.W. Froggatt (ANIC). 1♂, Cabramatta, 25.xii.1957, M.I.N.; 3♂♂, 1♀, Cabramatta, 9.xi.1958, MN; 1♂, Cabramatta, 1.xii.1960, M.I.N.; 1♂, Cabramatta, 7.i.1962, MN; 1♂, Cabramatta, 29.xi.1962, MN; 1♂, Fairfield, 20.x.1959, F. Edwards, 1♂, iv.1960; 4♂♂, Goodman's Ford, Wollondilly R., 9.xii.1954, RD.; 1♂, Windsor, 30.x.1952, RD.; 6♂♂, 2♀♀, Windsor, 9.xi.1952, RD. (MV). 2♂♂, 14 mi. S from Bonshaw on Glen Innes Rd, 11.xi.1973, M.S. Moulds; 2♂♂, Bungonia, 13.x.1973, G.R. Brown; 1♂, Failford, nr Taree, 7.i.1972, M.S. Moulds, 1♂, 8.i.1972; 3♂♂, 1♀, 9.i.1972; 1♀, c. 40 km N of Kyogle, on The Risk road, nr Qd border, 16.xii.1976, M.S. and B.J. Moulds; 2♂♂, Landsdowne, nr Taree, 27.xi.1980, M.S. and B.J. Moulds; 1♂, Mann

R. 5 km upstream from old Glen Innes-Grafton Rd crossing, 26.xi.1977, M.S. and B.J. Moulds, 3♂♂, 2♀♀, 16.xi.1981; 2♂♂, 2♀♀, Menai, W of Sutherland, Sydney, 14.xi.1983, R. Eastwood (MSM).

OTHER MATERIAL: QUEENSLAND: 1♂, Innisfail, 1957, A. Gillison (UQIC). This specimen is well beyond the normal range of *P. corticinus* and the record requires confirmation. VICTORIA: 3♂♂, Kyambram, 1947, J.C. Le Souef; 1♂, Mooroopna, 1.i.1924, F.E. Wilson; 1♂, Nagambie, 19.xi.1932, A.B.; 1♂, Nagambie, 17.xii.1932, A.B. (MV). Although these specimens are morphologically very similar to *P. corticinus*, there is some doubt regarding their correct identity, which may need to be confirmed by song data.

ETYMOLOGY

Corticinus derived from the Latin *corticus*, abounding in bark (of tree).

DESCRIPTION

MALE: *Head:* Predominantly black. Postclypeus shiny black anteriorly with narrow pale brown margin; rounded pale brown spot dorsally on midline; marginal silver pubescence; dorsal surface black with pale brown lateral margins and scattered short yellow-brown pubescence. Anteclypeus shiny black with conspicuous silver pubescence. Rostrum medium brown, becoming black apically; extends to mid coxae. Gena and mandibular plate black, with intervening pale brown suture and triangular area adjacent to postclypeus; conspicuous silver pubescence. Antennae deep brown. Ocelli pink-red. Eyes dark brown. Dorsal surface of head black with semicircular pale brown depressed area situated on longitudinal suture between ocelli; conspicuous silver pubescence behind eyes. Vertex lobes pale brown.

Thorax: Pronotum black with pale brown to ochraceous spindle-shaped central fascia, not extending to anterior or posterior pronotal margins; a pair of ochraceous dorsolateral asymmetric triangle-shaped areas adjacent to pronotal collar; short yellowish pubescence, especially adjacent to oblique fissures; pronotal collar pale reddish-brown.

Mesonotum black, with pair of pale to medium brown dorsolateral fasciae which broaden and nearly coalesce in median area; cruciform elevation pale brown, except for small black lateral patches; silver-yellow pubescence especially conspicuous around cruciform elevation and along pale brown wing grooves and adjacent ridges.

Legs: Coxae black with pale sandy-brown to brown fascia along margins; femora pale brown to reddish-brown with dark brown broad, longitudinal fasciae, and silver-yellow pubescence;

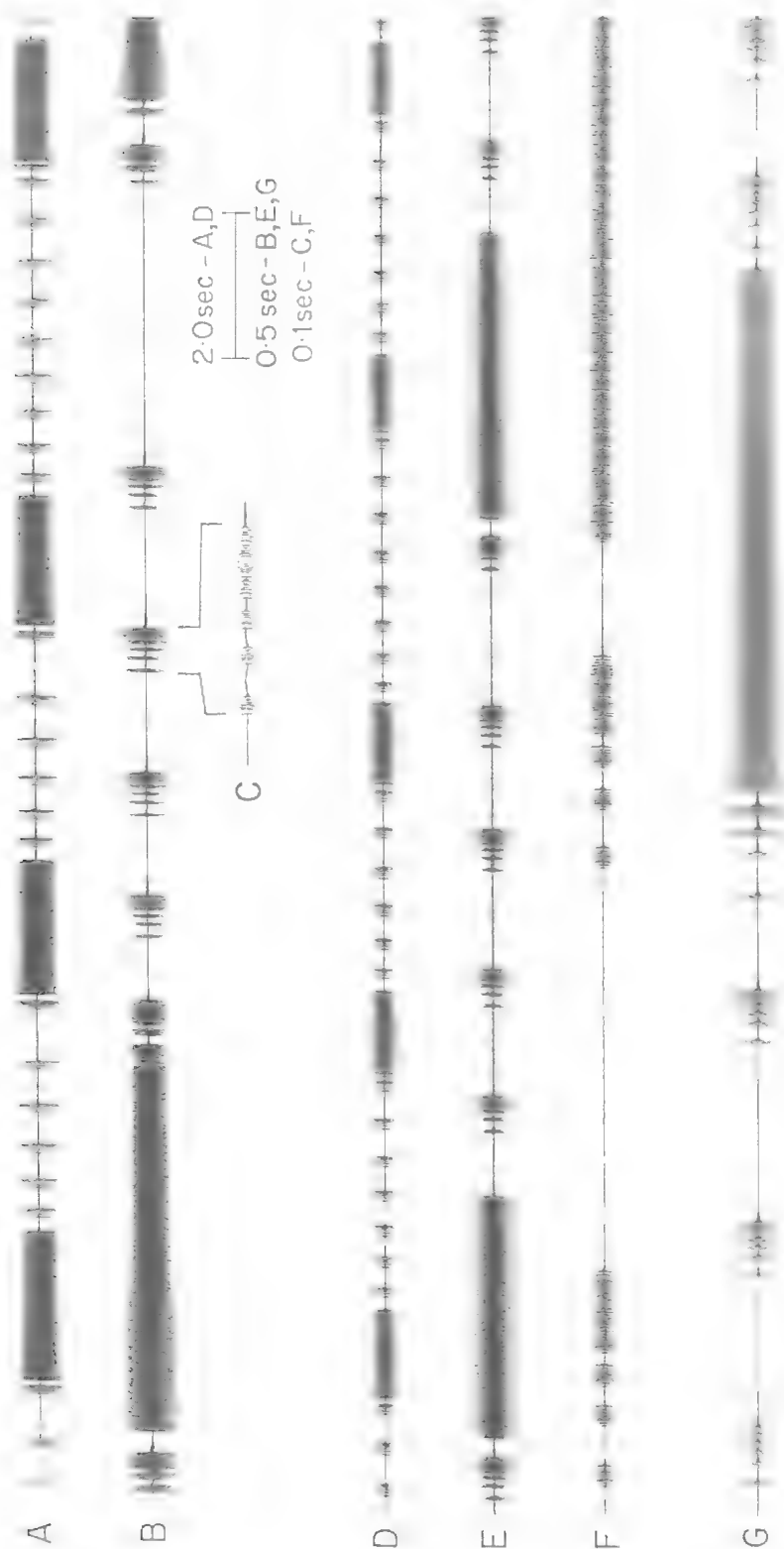


FIG. 17. Oscillograms of three sets of calling songs of *P. coriarius*, from Beerburum (north of Brisbane; A to C, Feb. 1978), Kroombit Tops (eastern central Queensland; D to F, Dec. 1983), and Carnarvon Gorge, central southern Queensland; G, Dec. 1985). Records shown at three different time scales, as illustrated on scale; B, E and G, for example, are run on same scale, and thus can be directly compared.

fore and mid tibiae dark brown, paler brown on hind tibiae; fore tarsi dark brown, becoming paler on mid and hind tarsi, claws and spines dark brown.

Wings: Fore wing venation castaneous, becoming darker distally towards apical cells and ambient vein; fore wing costal veins brown. Infuscation spots on hind wings conspicuous, spreading out from, and adjacent to the distal end of the 2A vein, along distal margin of anal lobe.

Tymbals: Two or three lower ridges joined anteriorly; dorsal ridge does not extend across dorsal inter-ridge sclerite; distinct basal spur.

Opercula: Roughly sickle-shaped, obliquely elongated and posteriorly rounded; relatively shiny and domed medially; declivous marginal flange, most conspicuous along outer margin; colour mostly black to deep brown over anterior and medial areas, pale yellow-brown along posterior marginal region; surface slightly rugose.

Abdomen: Tergites black with pale yellow to yellow-brown posterior margins; distinct dorsolateral to lateral reddish-brown bands adjacent to posterior margins of tergites 3 to 6, with similar, but paler bands on tergites 7 and 8, becoming broader and more irregular on 8; sparse silver pubescence most conspicuous dorsolaterally and laterally. Sternites dark brown to black, becoming slightly lighter towards sternites III and IV; posterior margin of each sternite pale yellow-brown; lateral silver pubescence; sternite VIII dark brown anteriorly, paler coloured posteriorly.

Genitalia: Colour mainly black to deep brown with paler lateral median area; upper pygophore lobes hypertrophied into a pair of terminally rounded, paddle-like blinkers extending laterally from pygophore; claspers contain hooked processes on inner margins; beak acute. Aedeagus with dorsal curved, tapering, and acute pseudoparameres, which join endotheca near gonocoxite IX; endotheca curved and sclerotised.

FEMALE: Basic markings and colouration as in male. Dorsal surface of head shows a thin pallid fascia extending from median ocellus to fronto-clypeal suture. Central fascia of pronotum broader, extending to anterior pronotal margin. Tergite 9 dominantly (>60%) black, becoming slightly paler laterally; silver-yellow dorsal pubescence. Sternites deep brown to black medially, the dark colouration extending outwards along the anterior margin of each sternite; remaining sternite colouration pale brown to yellow-brown; ovipositor sheath does not extend significantly beyond termination of tergite 9.

MEASUREMENTS: 75♂♂ and 41♀♀. Body length;

♂ 14.0-17.8 (15.94); ♀ 14.5-17.5 (15.95). Fore wing length: ♂ 16.0-20.3 (18.44); ♀ 17.8-21.3 (19.32). Head width: ♂ 4.5-5.5 (5.02); ♀ 5.0-5.6 (5.28). Pronotum width: ♂ 3.8-4.8 (4.23); ♀ 4.1-4.8 (4.46). Abdomen width: ♂ 4.1-5.2 (4.64); ♀ 4.1-4.7 (4.52).

COMMENTS

This species is similar to *P. fuscata* in morphology and distribution. The males are distinguished by the shapes of the pygophore upper lobes (terminally rounded, paddle-like blinkers in *P. corticinus*; hooked terminally in *P. fuscata*). Females differ in the intensity of the hind wing infuscation spots (strong in *P. corticinus*; weak in *P. fuscata*), the generally smaller body length of *P. fuscata*, and the more extensive black colouration on tergite 9 of *P. corticinus* (this being dominantly brown in *P. fuscata*).

DISTRIBUTION

This species extends from central eastern Queensland, near Mt Morgan, to south of Sydney, occurring coastally along New South Wales, and on the northern New England Tableland (Fig. 57). It is common throughout the southeastern corner of Queensland, including suburban Brisbane. In the northern part of its range, it occurs in higher country at Kroombit Tops, and is also common in the Carnarvon National Park, but not in the open dry lowland regions outside these tablelands. Specimens from northern Victoria need to be confirmed.

The habitat is open dry sclerophyll forest, in which it sings on the main trunks of dark coloured, and rough-barked trees (also dark fence posts) thereby being highly inconspicuous. It occurs from ground level to heights of about ten metres. The males tend to congregate locally, often along ridge crests. *P. corticinus* is found from September to April.

SONG

This is penetrating and readily identifiable in the field. It consists of short phrases (or perhaps more correctly referred to as compound phrase groups) most commonly four to ten in number, followed rapidly by a long phrase, the whole sequence being repeated (Fig. 17). The amplitudes of the short phrase groups, and the initial part of the long phrase, are of similar magnitude, there sometimes being a small amplitude decrease during the duration of the long phrase. The following notes refer to three specific calling song patterns.

The structures of the short phrases are similar, consisting of three (less commonly four) discrete

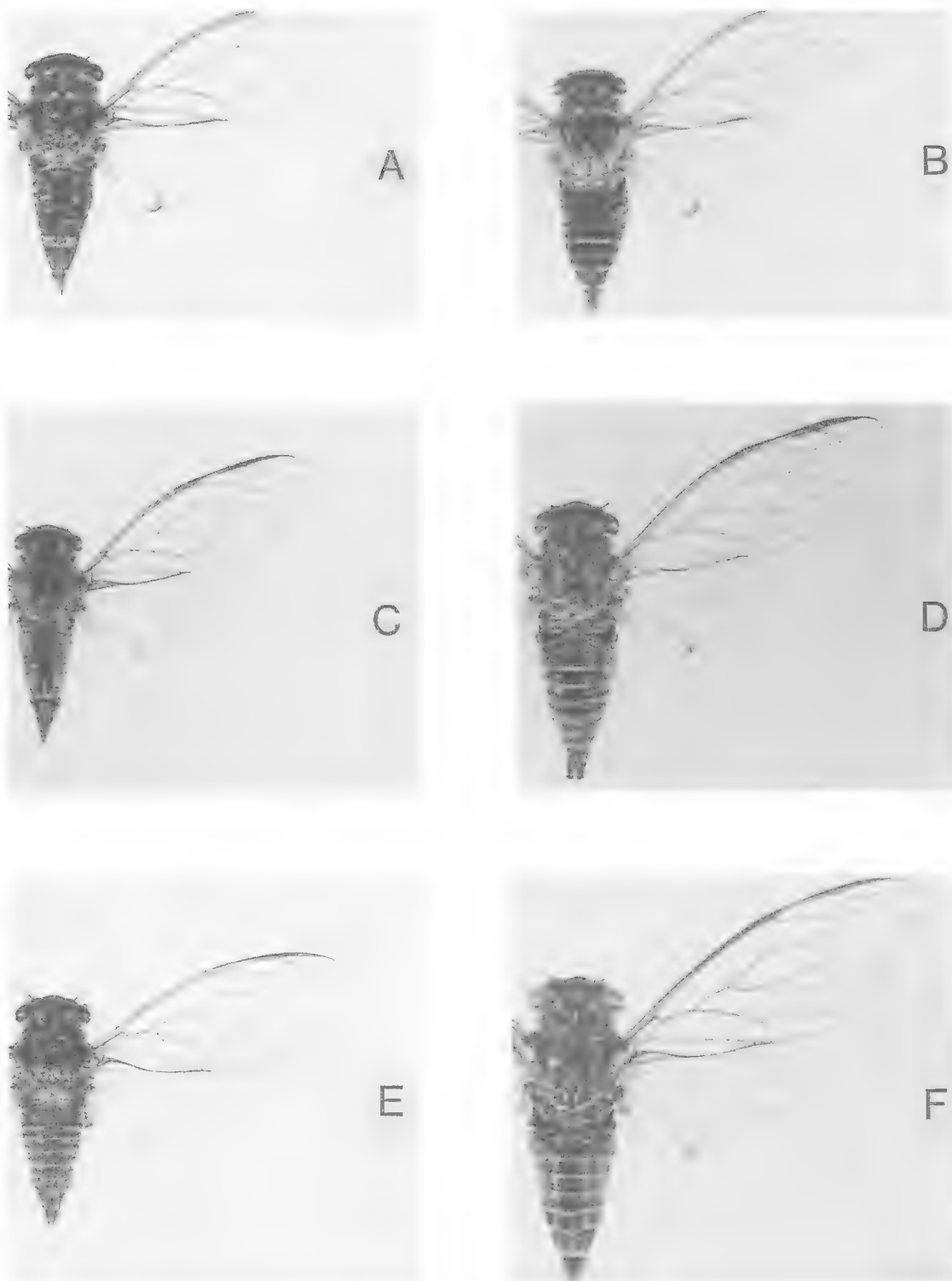


FIG. 18. A,B *P. corticinus* ♀, ♂. C,D *P. fuscata* ♀, ♂. E,F *P. collina* ♀, ♂. Photographs A,B,C and E $\times 2$ natural size; D and F $\times 2.7$ natural size. Photographs: D.M. Reeves

and separate pulse groups, followed by a longer composite pulse group; this latter in fact consists of three to four coalescing short pulse groups. The time intervals between the emission of the three short and following longer pulse groups progressively decrease, averaging approximately 25.5, 12.8 and 6 msec, respectively. In the example of the song recorded from the Carnarvon National Park, the final three or four pulse groups tend not to coalesce; thus, the short phrases in this case consist of 6 to 7 distinct pulse groups. The time intervals between each set of pulse groups for this song are 50-60 (first interval), 20-35, 15-20, 10-15, 2-15, 0-10 msec, respectively. Table 1 summarises comparative details of pulse group and phrase durations.

The overall song structure is developed from pulse groups with average durations of 16 msec, and which correspond to the short pulse groups forming the initial part of the short phrases. The longer phrases are formed by the coalescence of multiples of these pulse groups. On expanded time scales, each pulse group is seen to consist of nine

TABLE 1. Comparative data on calling song patterns of *P. corticinus*.

	Beerburum (south Queensland)	Kroombit Tops (central Queensland)	Carnarvon National Park (central Queensland)
Short phrases			
1. Overall duration (sec)	0.13-0.16 (av. 0.14)	0.14-0.16 (av. 0.15)	0.19-0.25 (av. 0.20)
2. Duration of short pulse groups (msec)	13-18 (av. 16.1)	15-16 (av. 15.9)	10-13 (av. 11.3)
3. Duration of final (longer) pulse group (msec)	41-59 (av. 50.8)	56-60 (av. 57.7)	11-35 (variable)
Long phrases			
1. Overall duration (sec)	1.3-2.5 (av. 1.9)	0.84-1.2 (av. 1.0)	0.51-1.92 (av. 1.1)
2. Duration between long phrases (sec)	3.2-6.0	1.7-3.7	2.7-3.3

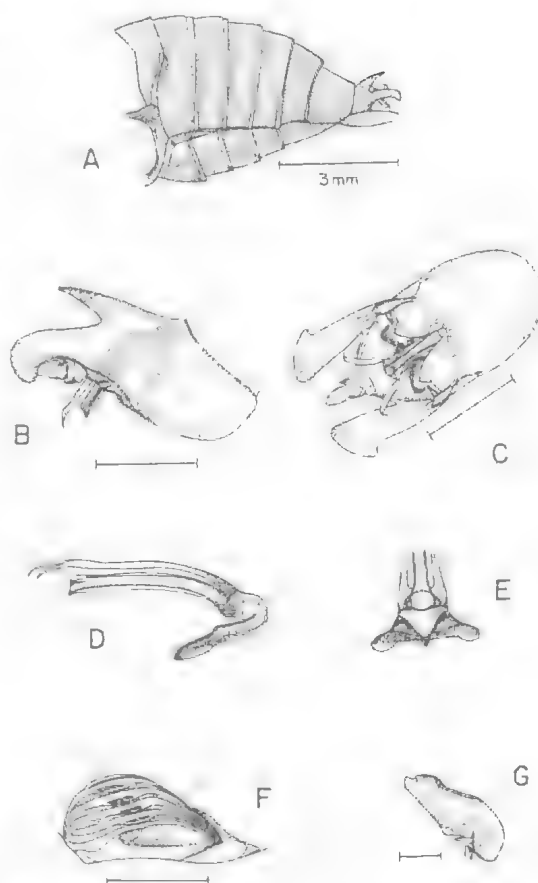


FIG. 19. *Pauropsalta fuscata* sp.n., ♂, based on specimen from Doolandella, southwestern Brisbane. Symbols A to G, and scales, as in Fig. 2.

distinct 'pulses', each of which is a complex pulse group whose structure cannot be further resolved with present data; these nine 'pulses' within each pulse group tend to cluster into triplets. The pulse repetition frequency is estimated to vary between 490-560 Hz.

***Pauropsalta fuscata* n.sp.**
(Figs 18,C,D,19-23,57)

Melampsalta (Pauropsalta) encaustica (Germar) Young,
1972:238,241, Pl. 1F.

Pauropsalta species B Ewart, 1986: 51-54, fig. 3B.

MATERIAL EXAMINED

HOLOTYPE: ♂ QUEENSLAND, Doolandella, Brisbane,
SEQ, 12.x.1981, A. Ewart (QM, Reg. No. T.9186).

PARATYPES: QUEENSLAND: 1♂, Doolandella, Brisbane, 11.x.1981, A.E.; 1♀, 8.ii.1982 (ANIC). 1♂, 1♀, Doolandella, Brisbane, 11.xii.1981, to light, A.E. (BMNH). 1♂, Doolandella, Brisbane, 11.x.1981, A.E. (MNDN). 1♂, NH, no date, coll. unknown (HEC). 2♀♀, 1♀, Brisbane, 28.ii.1954, J. Kerr; 1♂, 16.ix.1955, 1♀, 11.i.1957, 1♀, 15.i.1957; 1♀, Burleigh, 6.x.1966, AB; 1♀, Imbil, 26.x.1980, A. Nebois; 1♀, Mt Glorious, 3.i.1960, JK; 3♂♂, Palmwoods, 25.ix.1955, AB, 1♂, 3.x.1955, AB (MV). 1♂, Brisbane, 4.ii.1914, H. Hacker (QM). 2♀♀, 1♀, Blackdown Tableland, Expedition Range, 5-6.xii.1979, M.A. Schneider, G. Daniels; 2♀♀, Carnarvon Gorge, 7.xii.1979, mv lamp, G. Daniels, M.A. Schneider (UQIC). 1♂, nr Booyal on Childers to Gin Gin sect. of Bruce Hwy, Loc. 26, 1.ii.1973, J. Moss; 1♂, Booyal, nr Childers, 11.ii.1973, J.T. Moss; 1♂, 1♀, Caloundra, 3.ii.1980, J.T. Moss; 1♀, Doolandella, Brisbane, 27.ix.1982, J. Moss, A.E.; 1♂, Eldsvold, 25.xii.1984, J.T. Moss; 1♀, Pike's Ck, 11 mi. W of Pikedale, 4.xii.1966, T.G. Campbell; 2♂♂, Rainbow Beh, via Gympie (wallum), 28.i.1973, J.T. Moss; 1♂, Round Hill Hd, nr Town of 1770, 26.x.1973, J.T. Moss; 6♂♂, 1♀, Tin Can Bay (wallum), 11.xi.81, J.T. Moss; 1♂, Tin Can Bay, 18.x.1983, J.T. Moss; 1♂, Woolooga nr Gympie, 20.ii.1973, J.T. Moss (JM). 1♂, Beerburrum, 29.ix.1979, J. North; 1♂, Blackdown Tableland, Expedition Range, 10.xi.1973, A. Atkins, 1♀, 3.xi.1974, 2♂♂, 1♀, 9.xi.1974, G. Daniels, 1♀, 9.i.1976, 3♀♀, 8♀♀, 1-6.ii.1981, G.B. Monteith; 1♂, Carnarvon Gorge, 5.ix.1971, M.S. Moulds; 1♂, Doolandella, Brisbane, 17.xii.1981, A. Ewart, 1♀, 17.ii.1982; 1♀, Kinbombi Falls nr Goomeri, 19.xii.1976, M.S. and B.J. Moulds; 1♀, Maryborough, Rifle Range, 21.xi.1986, R. Eastwood; 1♂, Maryborough, Pistol Club, 22.xi.1986, R. Eastwood; 2♂♂, 20 km N of Monto, 6.xii.1979, M.S. and B.J. Moulds; 1♂, Mt Nebo, 500 m, nr Brisbane, 15.xii.1984, A. Hiller; 1♂, Mullen S.F. nr Tin Can Bay, 4.ix.1980, G. Daniels; 1♂, Porcupine Gorge, NNE of Hughenden, 11.ix.1983, A. Walford-Huggins; 1♂, Stockyard Ck, SE of Capalaba, 23.ix.1981, G. Daniels; 1♂, Wild Horse Mt, 21.xi.1985, R. Eastwood (MSM). 14♂♂, 3♀♀, Blackdown Tableland, Spring Ck camping area, 15-16.xii.1985, J.T. Moss, A.E.; 5♀♀, 1♀, Boolimba Bluff, Carnarvon N.P., 1.xi.1976, A.E.; 1♂, Burnett Ck, Mt Maroon, 16.xi.1975, A.E.; 2♀♀, Coolum, Wallum Research Stn, 17.x.1981, A.E.; 1♂, Doolandella, Brisbane, 27.ix.1981, A.E.; 3♂♂, 3♀♀, 11.x.1981, 4♀♀, 12.x.1981, 2♂♂, 11.xii.1981, 2♂♂, 1♀, 12.xii.1981, 1♀, 2.i.1982, 2♂♂, 22.i.1982, 1♀, 9.ii.1982, 3♀♀, 17.ii.1982, 2♀♀, 27.ix.1982, 3♂♂, 9.x.1983, 1♀, 14.x.1983, 1♀, 9.xi.1983; 1♀, Leyburn, 27.x.1979, D. Binns (AE). NEW SOUTH WALES: 1♂, Nelson Bay, 12.xi.1960, I.F.B. Common and M.S. Upton (ANIC). 1♂, Camden, 8.i.1948, A.B. and R.T.M.P.; 2♀♀, Coffs Harbour, xii.1948, F.D.; 2♀♀, Toronto, 24.ix.1931, AB (MV). 2♀♀, Elizabeth Beh, 16 km S Forster, 10.xi.1969, J.T. Moss; 2♀♀, Forestry Rd E of Stroud nr Bulahdelah, 7.xii.1967, J.T. Moss; 7♀♀, Kempsey, 11.xi.1984, J.T. Moss; 1♀, Laurieton, N Taree, 19.xii.1967, J.T. Moss; 1♀, 2♀♀, Macksville, 10.xi.1969, J.T. Moss; 4♂♂, South West Rocks nr Kempsey, 28.ix.1980, J.T. Moss (JM). 1♂, 14 mi. S from Bonshaw on Glen Innes Rd,

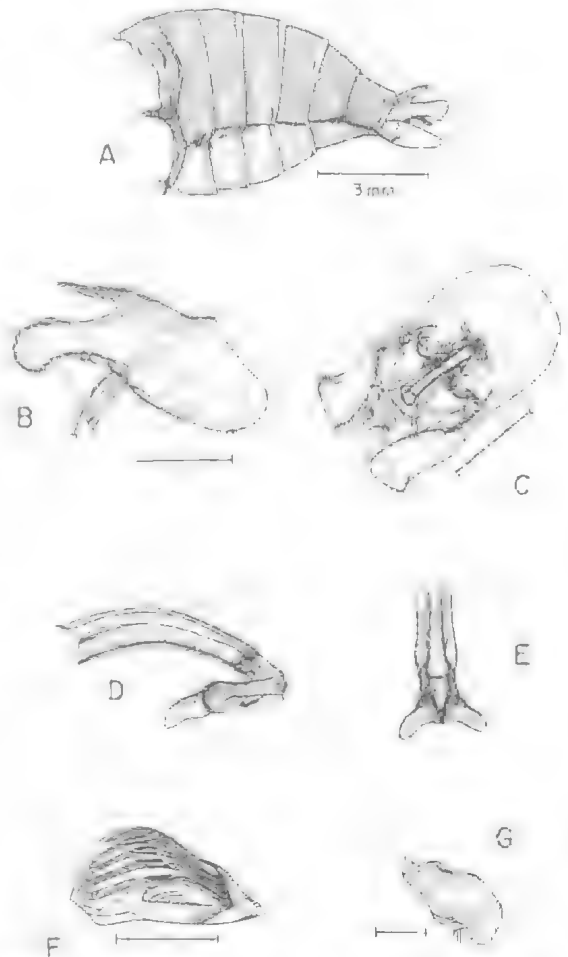


FIG. 20. *Pauropsalta fuscata* sp.n., ♂, from specimen from road between Wauchope-Port Macquarie, New South Wales. This is same specimen recorded by Young (1972) and listed under the species *P. encaustica*. Symbols A to G, and scales, as in Fig. 2.

11.xi.1973, M.S. Moulds; 1♂, c. 10 km NW Bonny Hills, dry scler. forest, 17.xii.1981, G. and T. Williams; 1♂, Bumbery, 30.xii.1976, prey of *Neoratus hercules*, G. Daniels; 1♂, Charmhaven, nr Gosford, 5.i.1972, M.S. Moulds; 1♂, S end Newell Hwy, NE Coonabarabran, 23.xi.1985, G. Williams, ex dry scler. forest; 5♀♀, Pailford, nr Taree, 7.i.1972, M.S. Moulds, 2♂♂, 8.i.1972; 4♂♂, Forster, 27.ix.1979, J. Olive; 1♂, 4 km N Garrawilla, 22.xi.1985, G. Williams, ex dry scler. forest; 1♂, Kew, nr Pt Macquarie, 10.i.1972, M.S. Moulds; 1♂, 1-2 km N of Kew, in dry scler. forest, 21.xi.1982, G. and T. Williams; 5♂♂, 1♀, L. Munmora, nr Doyalson, 1.xi.1987, M.S. and B.J. Moulds; 1♂, Trig. Rd, Lansdowne S.F., on casuarina trunks in dry scler. forest, 9.x.1981, G. and T. Williams, on young eucalypt; 1♂, NW sect. Lansdowne S.F., N of Taree, 17.xi.1983, dry scler. forest, G. Williams; 1♂, 4-5 km N of

Laurieton, 6.xi.1983, in dry scler. woodland, G. Williams; 3♂♂, Maria R. S.F., Kempsey, 15.xi.1974, G. Daniels; 1♂, Milperra, 18.xii.1966, G.R. Brown; 1♂, Mitchell's Island S.F., E Taree, in dry scler. forest, 6.xi.1981, G. and T. Williams; 1♂, N Brother Lookout, Camden Haven S.F., 6.xi.1980, on casuarina sp., G. and T. Williams; 1♂; 1♀, c. 2 km SW of Old Bar, in dry scler. forest on the trunks, 9.xi.1982, G. and T. Williams; 1♂, 5 km E Rocky Glen, in dry scler. forest, 24.xi.1981, G. and T. Williams; 6♂♂; 1♀, Smith L. nr Seal Rocks, Gahnia Swamp, 4.ix.1972, J.V. Peters, 1♂, 5.ix.1972; 1♂, S sect. Styx River S.F., NW of Kempsey, dry scler. forest, G. Williams and S. Watkins; 1♂, Upper Colo Colo R., 16.xii.1970, J.V. Peters; 2♂♂, Upper Eden Ck, Kyogle, 14.xi.1965, M.S. Moulds; 2♂♂, Yarratt S.F., NE Wingham, in dry scler. forest, 17.xii.1982, G. and T. Williams; 1♂, central W sect. Yarratt S.F. NE Wingham, dry scler. forest, 7.i.1984, G. Williams, C. Cross, 1♂, 3.ii.1984, G. Williams (MSM). 1♂, 4.5 km WSW of Drake via Tenterfield, 4.ii.1979, D. Binns; 2♂♂, 12.5 km WSW of Urbenville, 20.i.1979, D. Binns;

2♂♂, Wauchope-Pt Macquarie road, D. Young (song recorded and published in Young 1972); 1♀, 18 km NW of Woodenbong, 22.i.1979, D. Binns (AE).

ETYMOLOGY

Derived from the Latin *fuscus*, meaning dark or dusky.

DESCRIPTION

MALE: Head: Postclypeus black anteriorly with well defined pinkish-brown margin and a pinkish-brown spot dorsally on midline; dorsal surface black with short golden pubescence; golden pubescence in grooves between transverse ridges. Anteclypeus black, shiny, with conspicuous silver pubescence. Rostrum brown, becoming black apically; extends to mid coxae; silver pubescence present. Gena and mandibular plate black, with intervening pale brown suture; conspicuous silver-gold pubescence. Antennae black. Ocelli pink. Eyes medium brown. Dorsal surface of head black with pronounced pale brown triangular shaped and depressed suture between ocelli, apex pointing anteriorly, and extending from posterior edge of plate; short yellow-brown pubescence, becoming silvery and more conspicuous behind eyes. Vertex lobes brown.

Thorax: Pronotum black with pale brown central fascia not extending to pronotal collar, with wedge-shaped terminations; short golden pubescence; pronotal collar reddish-brown.

Mesonotum mostly black; a pair of dorsolateral brown fasciae, broadened and inward curving medially; cruciform elevation pale reddish-brown along ridges, black between ridges; short silver-gold pubescence present, becoming more conspicuous around cruciform elevation and along pale brown wing grooves and adjacent ridges.

Legs: Coxae predominantly black with reddish-brown longitudinal fasciae; mid and hind femora deep-brown to black with pale fasciae on inner margins; fore and mid tibiae and tarsi predominantly deep brown to black; hind tarsi pale brown; spines and claws deep brown to black.

Wings: Fore wing venation brown to reddish-brown, becoming darker distally; fore wing costal veins dark brown; pterostigma deep brown to black; infuscation spots on hind wings generally faintly developed.

Tymbals: The three lower ridges joined anteriorly; dorsal ridge extends across dorsal inter-ridge sclerite; distinct basal spur.

Opercula: Roughly sickle or kidney-shaped, obliquely elongated; declivous flange along outer and posterior margins; central region somewhat

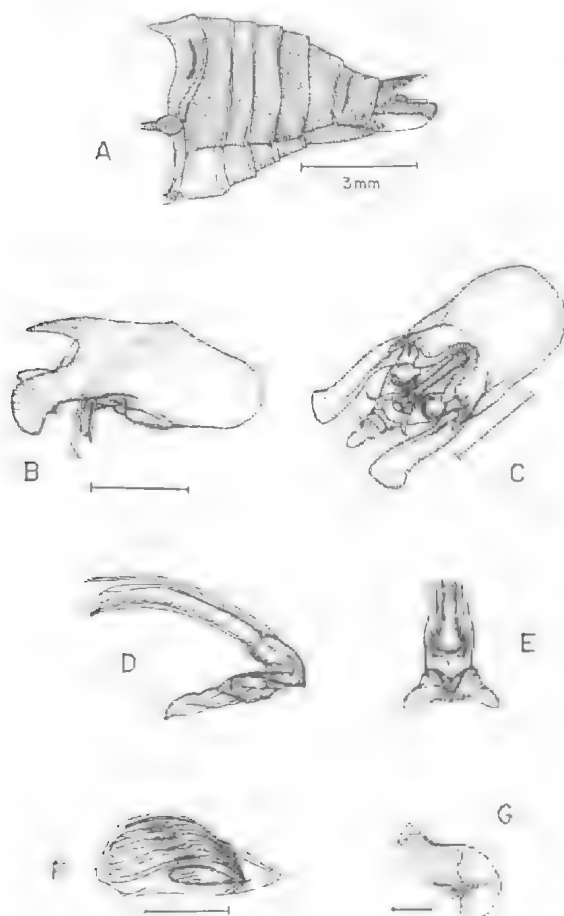


FIG. 21. *Pauropsalta fuscata* sp.n., ♂, based on specimen from Macksville, New South Wales (JM collection). Symbols A to G, and scales as in Fig. 2.

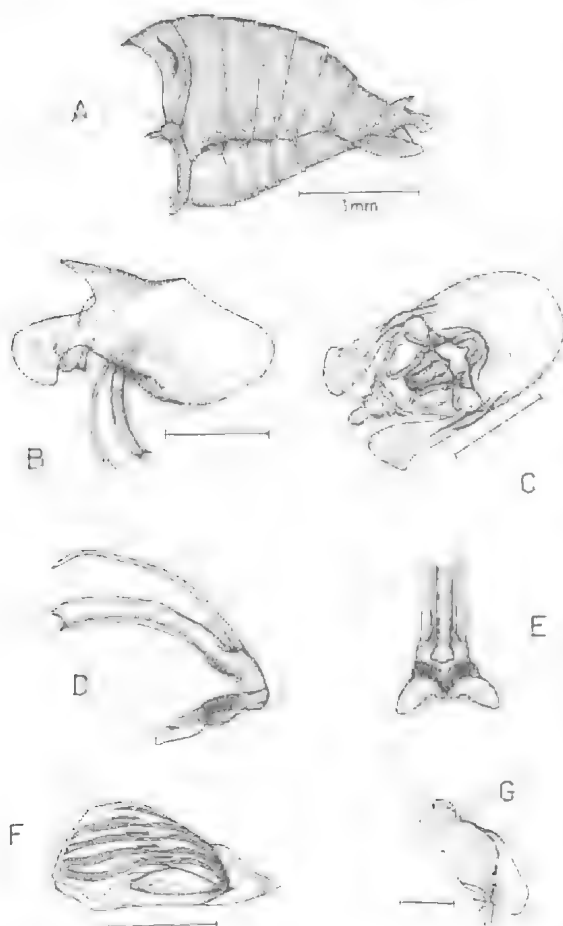


FIG. 22. *Pauropsalta fuscata* sp.n., ♂, from Carnarvon National Park, central southern Queensland. Symbols A to G, and scales as in Fig. 2.

domed, grading into the undulate posterior area; colour black with pale brown zone around posterior margin; prominent silver pubescence.

Abdomen: Tergites black with pale green-grey to pale brown posterior margins between tergites 3 to 8; tergites 4 to 8 exhibit a thin reddish-brown zone adjacent to the posterior margins, most conspicuous dorsolaterally. Sternites mainly black with minor lateral brown colouration on sternites III, decreasing in amount through to V; sternite VIII dark brown, becoming paler distally. Short silver-gold pubescence developed laterally.

Genitalia: Pygophore dominantly black; upper lobes hypertrophied into a pair of blinker-like structures which are rounded and strongly hooked terminally; beak well defined, tapering. Aedeagus with dorsal pseudoparameres longer than

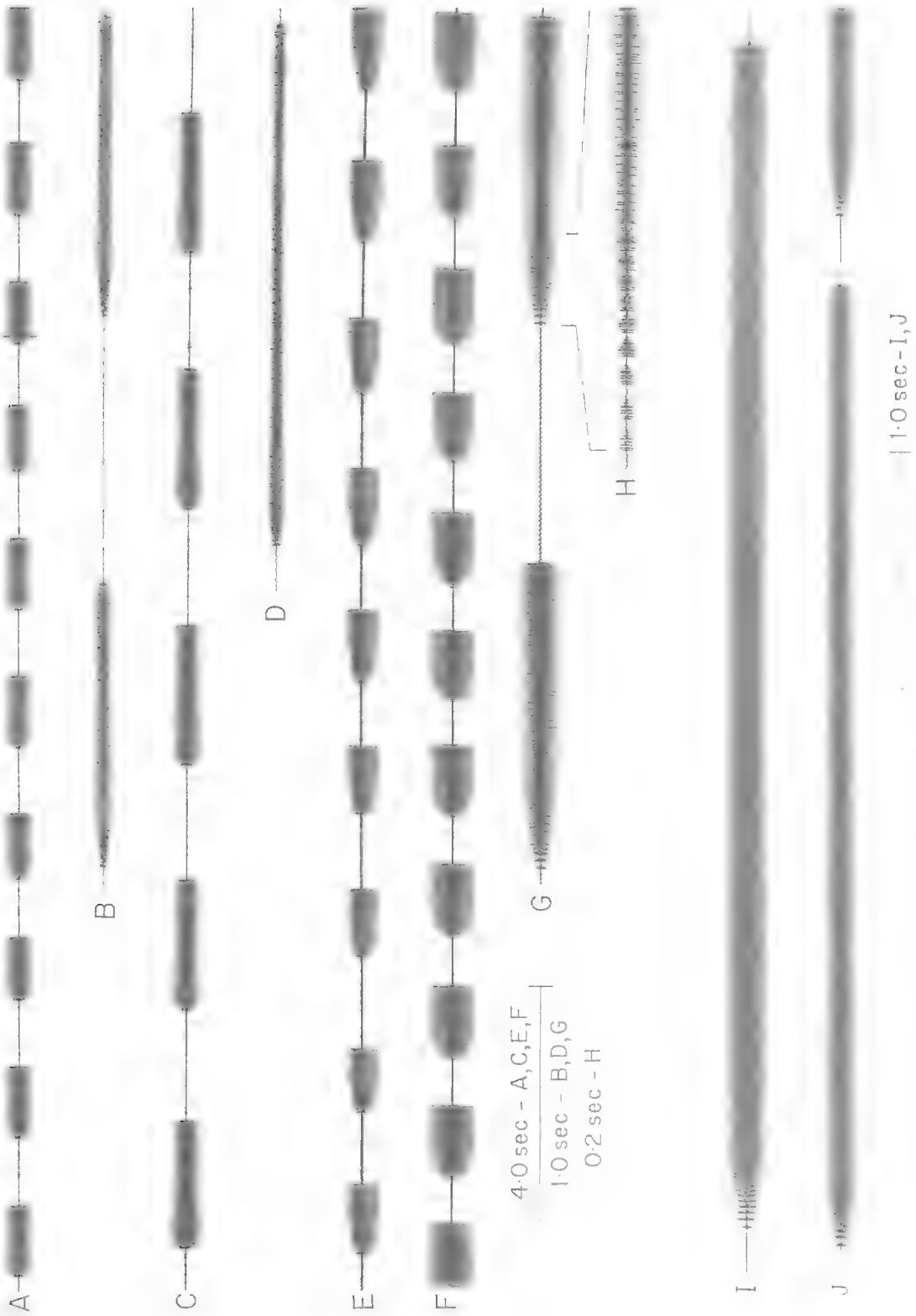
endotheca, apices tapering and curved; bifurcation of pseudoparameres occurs near to join with endotheca; endotheca characterised by a pair of lateral wing-like processes which taper towards base.

FEMALE: Head, thorax, legs, and wings similar to male. Tergites similar to male, except that the reddish-brown zones adjacent to posterior margins, occurring dorsolaterally to laterally on tergites 3 to 8, are more prominent and clearly defined; tergite 9 dark brown becoming paler posteriorly, with black dorsolateral black fasciae. Sternites III to VII deep brown to black medially, each dark area narrowing posteriorly; remaining colouration brown to reddish-brown; ovipositor sheath not extending significantly beyond termination of tergite 9.

LOCAL VARIANTS: At three localities towards the northern and northwestern limits of the known range of *P. fuscata* — Porcupine Gorge, near Hughenden, Blackdown Tableland and the Carnarvon Gorge — some morphological and song differences have been noted, and the species in these areas are believed to be represented by isolated populations. Specimens from the Carnarvon area are the most divergent, most notably with respect to male pygophore, tymbal, and opercula structures (Fig. 22). For example, the upper pygophore lobes are larger, while the spur-like process extending from the lower lobes are greatly reduced. The endotheca is characterised by larger terminal wing-like lateral processes, and is ornamented.

MEASUREMENTS: 43♂♂ and 10♀♀ from S Queensland; 12♂♂ and 2♀♀ from New South Wales. S QUEENSLAND: Body length: ♂ 11.7-16.8 (14.08); ♀ 13.2-15.0 (14.00). Fore wing length: ♂ 12.7-17.0 (15.69); ♀ 15.2-17.8 (16.48). Head width: ♂ 4.0-4.9 (4.46); ♀ 4.3-4.9 (4.60). Pronotum width:

FIG. 23. Oscillograms of six sets of calling songs of *P. fuscata*. These are from: A, B and C, D, two sets of songs from Doolandella, southwestern Brisbane (Sep. 1981, Oct. 1981); E, Elizabeth Beach, Foster, New South Wales (JM); F to H, road between Wauchope and Port Macquarie (this being the recording published by Young 1972, under the name *P. encaustica*; see also Fig. 20); I, Boolimba Bluff, Carnarvon National Park (central southern Queensland, Dec. 1985); J, Blackdown Tableland (central eastern Queensland, Dec. 1985). Three time scales are shown for the various recordings, as indicated by the scales; for example, records A, C, E, and F can be directly compared, as can records B, D, G, I, and J.



♂ 3.0-4.2 (3.74); ♀ 3.6-4.1 (3.85). Abdomen width: ♂ 3.5-4.6 (4.09); ♀ 3.6-4.1 (3.88). NEW SOUTH WALES: Body length: ♂ 13.7-17.0 (14.92); ♀ 14.0-14.2. Fore wing length: ♂ 15.7-18.3 (16.95); ♀ 16.3-16.8. Head width: ♂ 4.3-5.1 (4.69); ♀ 4.6. Pronotum width: ♂ 3.6-4.5 (3.92); ♀ 3.9-4.0. Abdomen width: ♂ 4.0-4.8 (4.33); ♀ 3.8-3.9.

COMMENTS

This species resembles *P. corticinus* and is distinguished as given in the description of *P. corticinus*. It is closest, however, to *P. collina* and, initially, the field recognition of these two species was made by male calling songs. Males are distinguishable on the basis of dorsal tymbal ridges (short, and not extending across dorsal inter-ridge sclerite in *P. collina*; longer, and extending beyond inter-ridge sclerite in *P. fuscata*) and colour of pygophore upper lobes (pale brown in *P. collina*; black in *P. fuscata*). Females, however, are usually very difficult to distinguish. Subtle differences in colouration are usually apparent, most notably the reddish-brown areas around the cruciform elevation and along the posterior edges of the tergites in *P. fuscata*; in *P. collina*, these areas are pale brown to pale pink. These differences are not necessarily diagnostic in all specimens.

DISTRIBUTION

Mainly coastal New South Wales, northwards from near Sydney, to coastal southeastern Queensland (Fig. 57). This species also occurs further inland, notably on the Blackdown and Carnarvon tablelands in Queensland, and the Coonabarabran area, New South Wales, which are all relatively elevated areas. There is a single record from Porcupine Gorge, near Hughenden.

Habitat preference is for open dry sclerophyll forest, extending to heathland and wallum on the coast. Although a much more subdued, and less conspicuous cicada than *P. corticinus*, both species completely overlap in habitats in southeastern Queensland. It typically rests and sings on tree trunks, posts, and shrubs. In southern Queensland, this species occurs between September to April and is uncommon in the later part of the season.

SONG

Within the main area of its range, the calling song consists of a regularly repeated phrase; initially, the amplitude increases rapidly, thereafter remaining constant (Fig. 23). The initial part of the phrase starts with a series of distinct composite pulse groupings, particularly well

defined in the song from the Wauchope specimen (Fig. 23G,H); the phrases finish abruptly. The expanded time scale (Fig. 23H) shows the phrases to comprise compound pulse groups, triply grouped, with a repetition frequency close to 400 Hz.

Young (1972) described this song under *P. encastica*, and the oscillograms illustrated in Fig. 23F-H are reproduced from his original tape, recorded between Wauchope and Port Macquarie. Although the song patterns shown in Fig. 23 have the same basic structures, and are taken as the most diagnostic criterion in grouping these cicadas into a single species, phrase and inter-phrase lengths are variable. For the four recorded songs (shown in part on the oscillograms in Fig. 23A-H), the phrase lengths are, respectively (A through to H), 1.0-1.4; 2.2-2.4; 1.1-1.4; and 1.2-1.3 secs. The corresponding inter-phrase intervals are 0.95-1.1; 1.88-1.94; 1.0-1.6; and 0.72-1.0 sec.

Aural observations on *P. fuscata* from the Carnarvon and Blackdown Tableland areas indicate that the phrases are significantly longer than for the other, more southerly populations, and this is confirmed by recordings; examples of phrases from these two localities are shown in Fig. 23I,J. The following phrase lengths are measured for these populations: 4.6-5.0 and 3.3-4.1 secs, respectively; corresponding inter-phrase intervals are 0.26-0.27 and 0.29-0.35 sec, respectively.

Pauropsalta collina n.sp. (Figs 18E,F, 24, 25, 57)

Pauropsalta species C Ewart, 1988:181, figs 1, 9B,C, Pl. 1B.

MATERIAL EXAMINED

HOLOTYPE: ♂ QUEENSLAND: Girraween National Park, 26.xi.1980, A. Ewart (QM, Reg. No. T.9187).

PARATYPES: QUEENSLAND: 1♂, 1♀, Girraween N.P., 26.xi.1980, A.E. (ANIC). 1♂, 1♀, Duntroon area, L. Broadwater, 30 km SW Dalby, 22.ii.1987, A.E. (BMNH). 1♂, 1♀, Duntroon area, L. Broadwater, 30 km SW Dalby, 22.ii.1987, A.E. (MNDN). 1♂, Glen Aplin, 28.x.1945, AG. (MV). 1♀, Girraween N.P., 26.xi.1980, A.E.; 1♀, Wyberba, 5-7.xi.1969, E.C. Dahms (QM). 1♂, Mr Norman, Wallangarra, 7-8.x.1972, B. Cantrell (UQIC). 2♂♂, Girraween N.P., nr Stanthorpe, 11.ix.1982, J.T. Moss; 1♂, 24.xii.1983; 1♂, Goomburra For. Res. nr Allora via Warwick, 21.xi.1984, J.T. Moss; 1♂, 'Kragra', Chinchilla, Euc. maculata, Bulloak, and Acacia sp. ?crassa, ridge, 29.i.1986, Grace Lithgow; 7♂♂, Leslie Dam, via Warwick, 18.xi.1984, J.T. Moss (JM). 1♂, Dalveen, N of Stanthorpe, 19.xii.1951, V. Fanning; 1♂, Fletcher, nr Stanthorpe, 24.x.1963, M.S. Moulds; 2♂♂, L. Broadwater nr Dalby, site B, 27°21'S 151°06'E, 28.ix.1986, G. and A. Daniels; 2♂♂, 6 km N

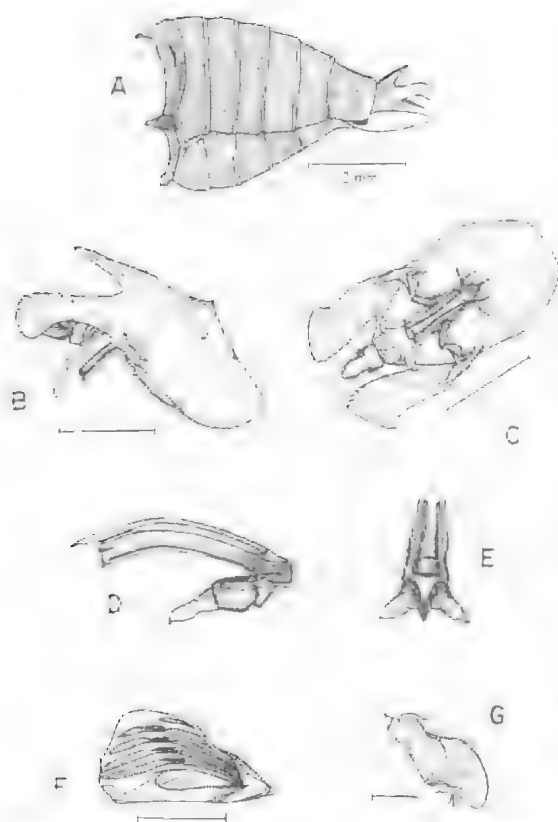


FIG. 24. *Pauropsalta collina* sp.n., ♂, from Girraween National Park, southern Queensland. Symbols A to G, and scales, as in Fig. 2.

Leyburn, 27°58'S 151°38'E, 22.x.1985, G. Daniels (MSM). 1♂, Camp Mt via Samford, 2.xii.1978, A.E.; 19♂♂, 25♀♀, Duntroon area, L. Broadwater, 30 km SW Dalby, 22.ii.1987, A.E.; 1♂, 1♀, Girraween N.P., 26.xi.1980, A.E.; 1♂, Tom Plants lagoon, Stanthorpe, i.1981, D. Reeves (AE). NEW SOUTH WALES: 1♂, Bald Rock N.P., 30.xi.1981, M.A. Schneider and G. Daniels (UQIC). 2♂♂, 1♀, 5 km N Bolivia Hill, 30 km S Tenterfield, 3.i.1988, J.T. Moss (JM). 2♂♂, Dundee nr Glen Innes, 6.xii.1962, M.S. Moulds, 2♂♂, 9.xii.1962, 6♂♂, 12.xii.1962, 1♂, 12.xi.1963, 1♂, 13.xi.1963, 1♂, 19.xi.1963, 1♂, 20.xi.1963, 1♂, 6.xii.1963, 1♂, 12.xi.1983; 1♀, Glen Innes. 20.xi.1966, M.S. Moulds; 10♂♂, 4♀♀, Main Camp Ck, c. 27 km E Deep Water, 13.xi.1973, M.S. Moulds (MSM). 2♂♂, Billyrimba Lookout via Tenterfield, c. 1100 m, 13.i.1979, D. Binns (AE).

ETYMOLOGY

Derived from Latin *collina*, high ground or hill.

DESCRIPTION

MALE: Head: Postclypeus shiny black anteriorly with sharply defined, narrow pale pink-brown

margin, extending slightly into grooves between transverse ridges; small median brown spot dorsally on midline; silver-yellow pubescence; dorsal surface black with short yellow-gold pubescence. Anteclypeus shiny black with conspicuous silver pubescence. Rostrum pale brown grading to black apically, extends to mid coxae. Gena and mandibular plate black with intervening pale brown suture; conspicuous silver pubescence. Dorsal surface of head black with short yellow pubescence, and pallid depressed longitudinal suture between ocelli. Ocelli deep red. Eyes medium brown. Vertex lobes pale reddish-brown.

Thorax: Pronotum black with pale brown, spindle-shaped, short central fascia; short yellowish pubescence, especially concentrated adjacent to oblique fissures; anterior margin pale brown dorsolaterally; pronotal collar black with narrow reddish-brown margin.

Mesonotum mostly black; dorsal region of cruciform elevation predominantly pale pink to pale brown, except for a narrow black longitudinal fascia; short, narrow, pale reddish-brown dorsolateral fasciae extend from anterior arms of cruciform elevation; wing grooves and ridges pale brown to pale reddish-brown.

Legs: Coxae black with red-brown longitudinal fasciae along margins; fore femora with alternate black and pale red-brown fasciae; mid and hind femora black to deep brown, pallid distally; fore tibiae black; mid tibiae deep brown to pallid; hind tibiae pallid; fore tarsi black, becoming paler towards hind tarsi; claws and spines deep brown to black.

Wings: Fore wing venation reddish-brown becoming darker distally around apical cells and ambient veins, with dark costal veins; pterostigma black; infuscation along vein 1A + 2A of fore wing very faint; infuscation spot at anal margins of hind wings dark brown.

Tymbals: Dorsal ridge does not extend across dorsal inter-ridge sclerite; lower ridges not obviously joined anteriorly; distinct basal spur.

Opercula: Roughly sickle-shaped, obliquely elongated, broadly rounded along inner terminations; longitudinally undulate (i.e. parallel to body axis); colour black, grading to dark-brown along posterior marginal region; declivous flange developed especially along outer margin; surface somewhat shiny on anterior half of opercula, becoming finely rugose posteriorly; silver pubescence.

Abdomen: Tergites black with distinct pale yellow-brown posterior margins; tergites 3 to 7

with narrow reddish-brown to orange-brown dorsolateral to lateral zones adjacent to posterior margins of each tergite, becoming broader and more conspicuous towards tergite 7; tergite 8 with distinct pale brown zone extending around the whole posterior margin; sparse, short silver pubescence. Sternites predominantly black to deep brown, slightly paler dorsolaterally on sternites III and IV, and pale brown on posterior area of sternite VII; posterior margins of sternites pale yellow-brown; sternite VIII mostly pale to medium brown.

Genitalia: Colour black grading to pale brown on upper lobes; upper lobes hypertrophied into a pair of blinker-like structures with acutely angulated terminations; lower lobes distinct; inner lobes somewhat rounded apically; claspers pointed apically; aedeagus with a pair of dorsal pseudoparameres, apically acute and tapering, each with a distal hair-like process; pseudoparameres join endotheca near to gonocoxite IX; endotheca sclerotised with a pair of terminal lateral wing-like processes.

FEMALE: General colouration and markings similar to male, but with decreased proportion of black colouration. Pronotum with a more conspicuous pale yellow-brown to greenish-brown central fascia and brown pronotal collar, becoming reddish-brown along margin. Mesonotum black with conspicuous pale greenish-brown dorsolateral fasciae extending to anterior arms of cruciform elevation; cruciform elevation pale brown to reddish-brown; wing grooves and ridges reddish-brown. Wings and legs as in male. Abdomen: Tergites black with narrow pale brown dorsolateral to lateral zones along posterior edges of tergites 3 to 8, becoming broader and more conspicuous towards tergite 8; tergite 9 mainly pale brown with black fascia. Sternites pale brown to sandy-brown with broad median black fascia; ovipositor sheath not extending significantly beyond termination of tergite 9.

MEASUREMENTS: 20♂ and 14♀♀. Body length: ♂ 13.7-15.7 (14.90); ♀ 13.5-16.3 (14.55). Fore wing length: ♂ 15.7-18.3 (17.04); ♀ 16.3-18.3 (17.05). Head width: ♂ 4.6-5.1 (4.82); ♀ 4.6-5.2 (5.03). Pronotum width: ♂ 3.8-4.3 (4.01); ♀ 3.9-4.5 (4.26). Abdomen width: ♂ 3.9-4.6 (4.26); ♀ 3.8-4.5 (4.15).

COMMENTS

This species is most similar to *P. fuscata* and differences are noted in the discussion of that species. *P. collina* is also very similar to *P. encaustica*, although their distributions do not overlap. Females of these two species are very

similar, but males are distinguished by colour of pygophore upper lobes (tending to pallid in *P. encaustica*; brown in *P. collina*), and relative lengths of dorsal tymbal ridge (short, not extending beyond dorsal inter-ridge sclerite in *P. collina*; longer, extending beyond dorsal inter-ridge sclerite in *P. encaustica*). Songs are very distinctive.

P. collina is also superficially similar to *P. siccanus*, but is easily distinguished by tymbal ridge structures (compare Figs 24F, 26F); the presence of two very distinct hind wing infuscation spots in *P. siccanus*; and sternite colouration (paler with clearly defined median black fascia in *P. siccanus*, although this colour difference is not as clearly defined in female specimens).

DISTRIBUTION

The species occurs extensively in the high country of the granite belt of northeastern New South Wales and southeastern Queensland, north from Glen Innes (New South Wales), through the Stanthorpe region to Warwick (Leslie Dam), the Main Range mountains east of Allora, and westwards to near Dalby and Chinchilla (Fig. 57). A single record exists from the lower D'Aguilar Range, north of Brisbane. The overall distribution is thus confined to the higher areas of southeastern Queensland and northern New South Wales and mainly associated with granitic and sandy soils. Habitat is open dry sclerophyll forest.

This species is active between September to March.

SONG

This is unique amongst the southern Queensland cicadas so far studied, but regional variation is found amongst southerly populations.

Girraween and Lake Broadwater songs (Fig. 25A-E): These consist of regularly repeated phrases, each phrase of between 0.45-0.62 (av. 0.58) sec duration, with an interphrase interval varying between 0.26-0.4 (av. 0.38) sec. Each phrase starts abruptly with a constant high amplitude portion, lasting between 0.22-0.29 sec, which is then rapidly damped to a low amplitude phase; this latter progressively decreases, and then increases in amplitude before abruptly ceasing. To the ear, the song has a peculiar 'twang' sound. Examination on an extended time scale (Fig. 25B) suggest that the initial high amplitude portion of each phrase has two superimposed phases, a high and a low amplitude phase, the latter continuing through the complete phrase. This low amplitude phase comprises separate pulse groups, each of

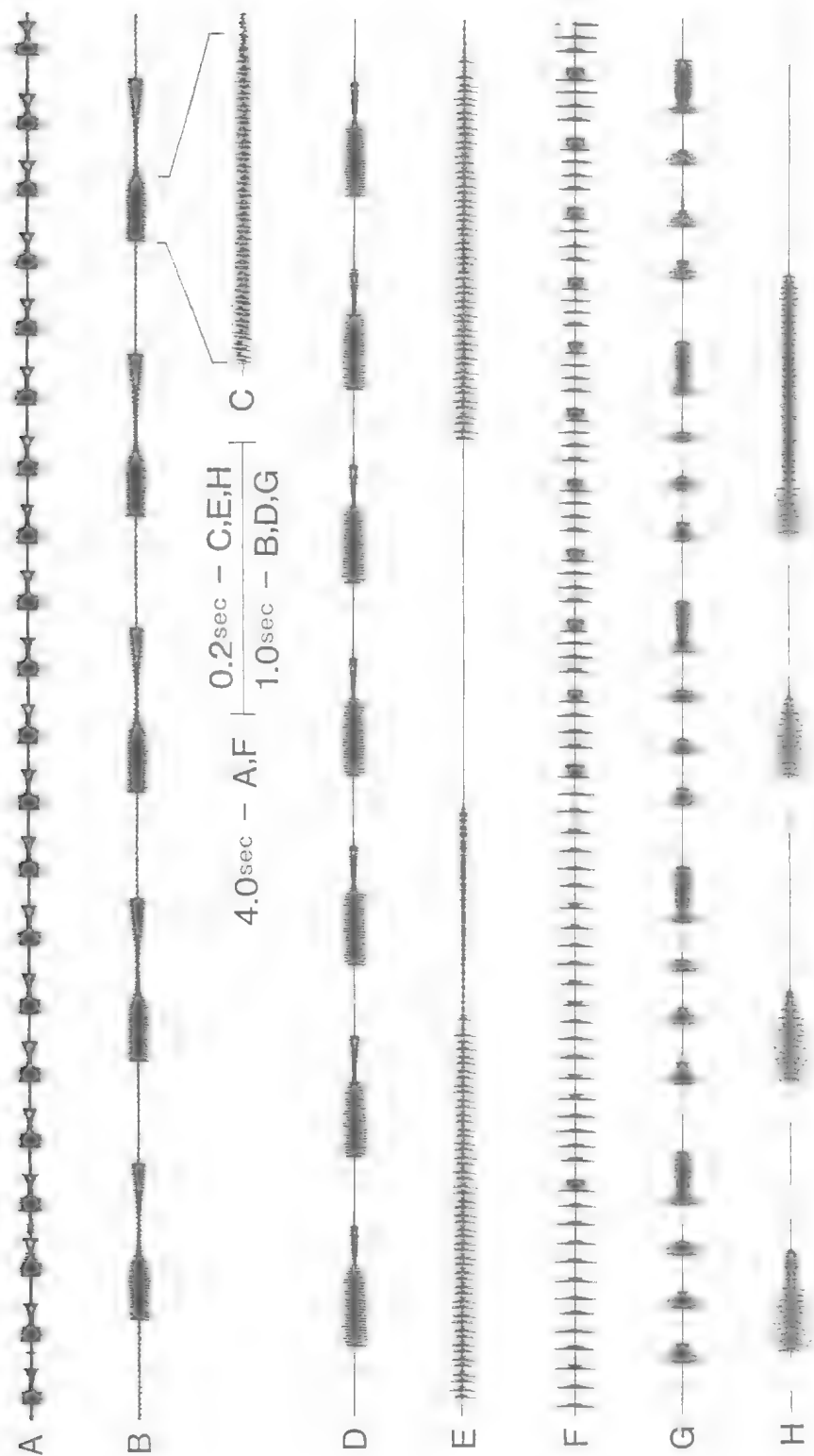


FIG. 25. Oscillograms of three sets of calling songs of *P. collina*. A to C, Girraween National Park (Nov. 1980; shown at three time scales). D and E, Lake Broadwater (30 km SW Dalby, southeastern Queensland; February 1987). F to H, 5 km N of Bolivia Hill (30 km south of Tenterfield, northeastern New South Wales; January, 1988; shown at three time scales).

approximately 2 to 3 msec duration, separated by intervals of approximately 1.5 to 3 msec which markedly decrease in the final increasing amplitude portion of the phrase. The high amplitude phase consists of discrete and sharply defined pulse groups, which occur in pairs; intervals between pairs are approximately 5 msec, while between the paired pulse groups are approximately 3.8 msec. The overall repetition rate of the high amplitude phase is 225-230 Hz. Each pulse group consists of four almost superimposed pulses.

Bolivia Hill song (30 km S of Tenterfield, New South Wales; Fig. 25F-H): This is a more variable song, although still comprising regularly repeated phrases each with an initial high amplitude portion, followed abruptly by a damped, low amplitude portion which usually (but not always) increases slightly in amplitude before abruptly ceasing. The individual phrase lengths are shorter than observed in the previously described songs, varying from 80-220 msec duration. The initial high amplitude portions, however, are of less variable length (between 40-50 msec). It is the low amplitude portions of each phrase that are clearly most variable. It is seen from Fig. 25F,G that certain portions of the song show systematic changes of phrase structure, the sequence repeated every four phrases. Phrase lengths progressively decrease in the first three phrases of each sequence followed by a long final phrase, as follows: 70-80 msec (first phrase); 60-70 msec; 40-60 msec; 190-220 msec (final phrase of sequence). Interphrase intervals vary from 110-140 msec within each phrase sequence, but between each sequence of four phrases, range between 210-240 msec. Only the final phrase of each sequence produces the distinctive 'twang' as heard aurally. The expanded time scale oscillogram (Fig. 25H) shows that the structures of the low amplitude portions of each phrase are similar to the songs described previously. The pulse structure of the higher amplitude portions are not arranged as pairs of pulses, the individual pulses being more complex, each of approximately 4 msec length, with a similar interval between pulses.

***Paupsalta siccanus* n.sp.**
(Figs 26,27,52C,D,57)

Paupsalta species F Ewart, 1988:182, figs 4,11G,H, Pl. 4G.

MATERIAL EXAMINED

HOLOTYPE: ♂ QUEENSLAND: Injune-Rolleston Rd, 15

km S of Wyseby Jct, 7.xii.1985, J.T. Moss, A. Ewart (QM, Reg. No. T.11152).

PARATYPES: QUEENSLAND: 1♂, Injune-Rolleston Rd, 15 km S Wyseby Jct, 11.xii.1985, J.T. Moss, A.E. (ANIC). 1♀, Injune-Rolleston Rd, 15 km S Wyseby Jct, 7.xii.1985, J.T. Moss, A.E. (QM). 3♂♂, Injune-Rolleston Rd, 15 km S Wyseby Jct, 11.xii.1985, J.T. Moss, A.E. (JM). 50♂♂, 46♀♀, Clermont, 7.ii.1981, M.S. and B.J. Moulds; 2♂♂, L. Broadwater nr Dalby, site A, 27°21'S 151°06'E, 24.xii.1986, G. and A. Daniels, mv lamp; 13♂♂, Yelarbon, 17.xi.1962, M.S. Moulds (MSM). 1♂, dry scrub country on tree trunk, 15 km S of Amby, 4.ii.1982 A.E.; 1♂, Augathella, xi.1978, M. Hawkins; 1♂, Clermont, 7.ii.1981, M.S. and B.J. Moulds; 1♂, 51 km N of Injune, Injune-Rolleston Rd, 7.xii.1985, J.T. Moss, A.E.; 1♂, 93 km N of Injune, Injune-Rolleston Rd, 7.xii.1985, J.T. Moss, A.E.; 7♂♂, 1♀, L. Broadwater, 30 km SW Dalby, casuarinas, 17.xii.1987, A.E.; 1♂, L. Broadwater, S side lake, 30 km SW Dalby, 17-20.xii.1987, A.E. (AE). NEW SOUTH WALES: 3♂♂, 1♀, Nandewar Range Foothills, 15.xii.1971 (M46), J.T. Moss (JM).

ETYMOLOGY

Derived from Latin *siccanus*, meaning dry. This refers here to the inland dry country occurrence of this insect.

DESCRIPTION

MALE: Head: Postclypeus; shiny black anteriorly with clearly defined brown margin and conspicuous pallid area dorsally on midline; dorsal surface black with median thin pallid fascia extending to, and broadening adjacent to frontoclypeal suture; silvery pubescence anteriorly. Anteclypeus shiny black with silver pubescence. Rostrum brown becoming black apically; extends just beyond mid coxae, but not to hind coxae. Gena and mandibular plate black with intervening narrow brown suture and marginal ridges; conspicuous silver pubescence. Antennae deep brown. Vertex lobes brown. Ocelli pink. Eyes dark brown. Dorsal surface of head black with pallid triangular area on longitudinal suture between ocelli; silver pubescence especially conspicuous behind eyes.

Thorax: Pronotum black with narrow brown anterior margin and pronotal collar, and pale broad central fascia which does not extend to pronotal collar; two small dorsolateral pale triangular areas adjacent to pronotal collar; short silver pubescence.

Mesonotum black with a pair of dorsolateral pale greenish-brown fasciae, widening inwards medially; cruciform elevation pale reddish-brown, black anteriorly; wing grooves pale brown; silver pubescence adjacent to wing grooves and cruciform elevation.

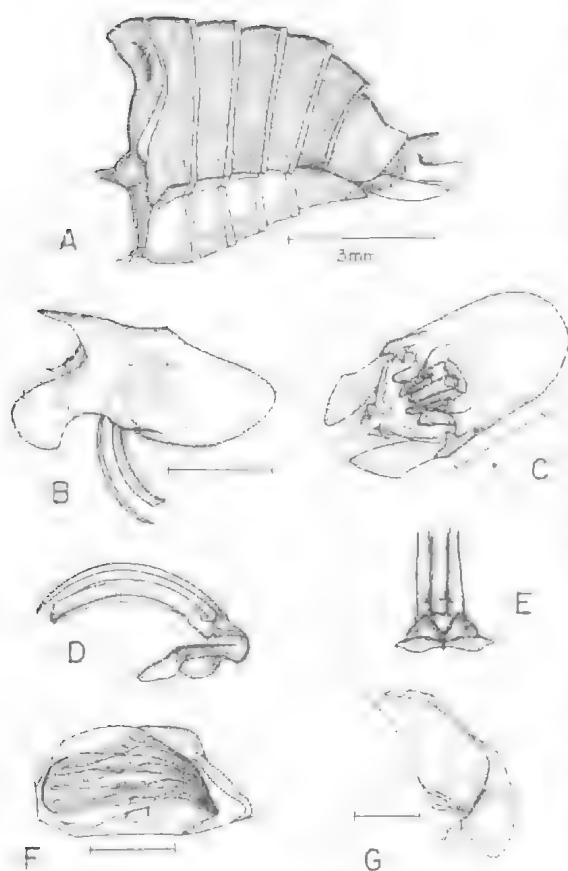


FIG. 26. *Pauropsalta siccanus* sp.n., ♂, from Injune-Rolleston road, 93 km N of Injune (central southern Queensland). Symbols A to G, and scales, as in Fig. 2.

Legs: Coxae black with brown outer margins on fore coxae; femora black, with paler diffuse longitudinal fasciae on fore femora; tibiae black; fore tarsi black, becoming paler on mid and hind tarsi; claws and spines black to dark brown.

Wings: Venation dark brown, paler along costal and sub costal veins of fore wings, and adjacent to anal lobes of hind wings; very distinct and diffuse infuscation on hind wings at termination of 2A vein, and a second very distinct infuscation in clavus, adjacent to plaga.

Tymbals: Dorsal ridge short and relatively wide; three central ridges relatively wide; the three or four lower ridges joined anteriorly; basal spur indistinct or absent.

Opercula: Broadly sickle-shaped, elongated, with sharply elevated central region; relatively sharply rounded inward (posterior) termination; marginal declivious flange around outer margin:

colour dominantly black except for pale brown zone adjacent to posterior margin; surface finely rugose.

Abdomen: Tergites 2 to 8 black with conspicuous yellow to yellow-orange posterior margins; posterior margin of tergite 8 irregularly yellow-brown. Sternites III to VI yellow-brown with broad, dark median fascia; sternite VII dark brown to black; sternite VIII dark anteriorly, otherwise pale brown.

Genitalia: Pygophore black anteriorly, otherwise pale sandy-brown; upper lobes hypertrophied and tending to be developed into a shallow hook-like shape; inner and lower lobes distinct, with the pair of inward pointing, curved, triangular-shaped spur-like processes developed from lower lobes; a pair of hooked claspers; dorsal, curved pseudoparameres longer than endotheca, and which bifurcate and join endotheca near, but not adjacent to gonocoxite IX; endotheca cylindrical and curved.

FEMALE: Colouration and markings similar to male, with head and thorax identical. Legs slightly paler, with prominent longitudinal pale fasciae on fore femora. Tergites 2 to 8 dominantly black, but with narrow and irregular transverse, pale brown bands adjacent to posterior margins of each tergite; tergite 9 dorsally and anteriorly black, otherwise pale sandy-brown with posterior lateral black spot. Sternites pale yellow-brown with prominent median dark fascia. Ovipositor sheath black, extending beyond tergite 9 by up to approximately 0.5 mm.

MEASUREMENTS: 8♂♂ and 2♀♀. Body length: ♂ 12.7-14.7 (13.58); ♀ 13.7-14.2. Fore wing length: ♂ 15.2-16.8 (16.13); ♀ 16.8-17.0. Head width: ♂ 4.0-4.6 (4.30); ♀ 4.4-4.5. Pronotum width: ♂ 3.3-4.0 (3.68); ♀ 3.5-3.8. Abdomen width: ♂ 4.0-4.8 (4.39); ♀ 4.0.

COMMENTS

This species is similar to *P. corticinus*, *P. fuscata* and *P. collina*, and could also be confused with *P. annulata* (see descriptions). The most useful characters for distinguishing *P. siccanus* from these species are the two distinct infuscation spots on each of the hind wings, together with the broad dark fascia on the ventral side of the abdomen. In the field, the 'chirping' song of *P. siccanus* is very characteristic, and, in fact, enabled its initial discovery. The short thick dorsal tymbal ridge is also a useful male distinguishing character.

DISTRIBUTION

This species occurs through central to southern central Queensland, from Clermont south through

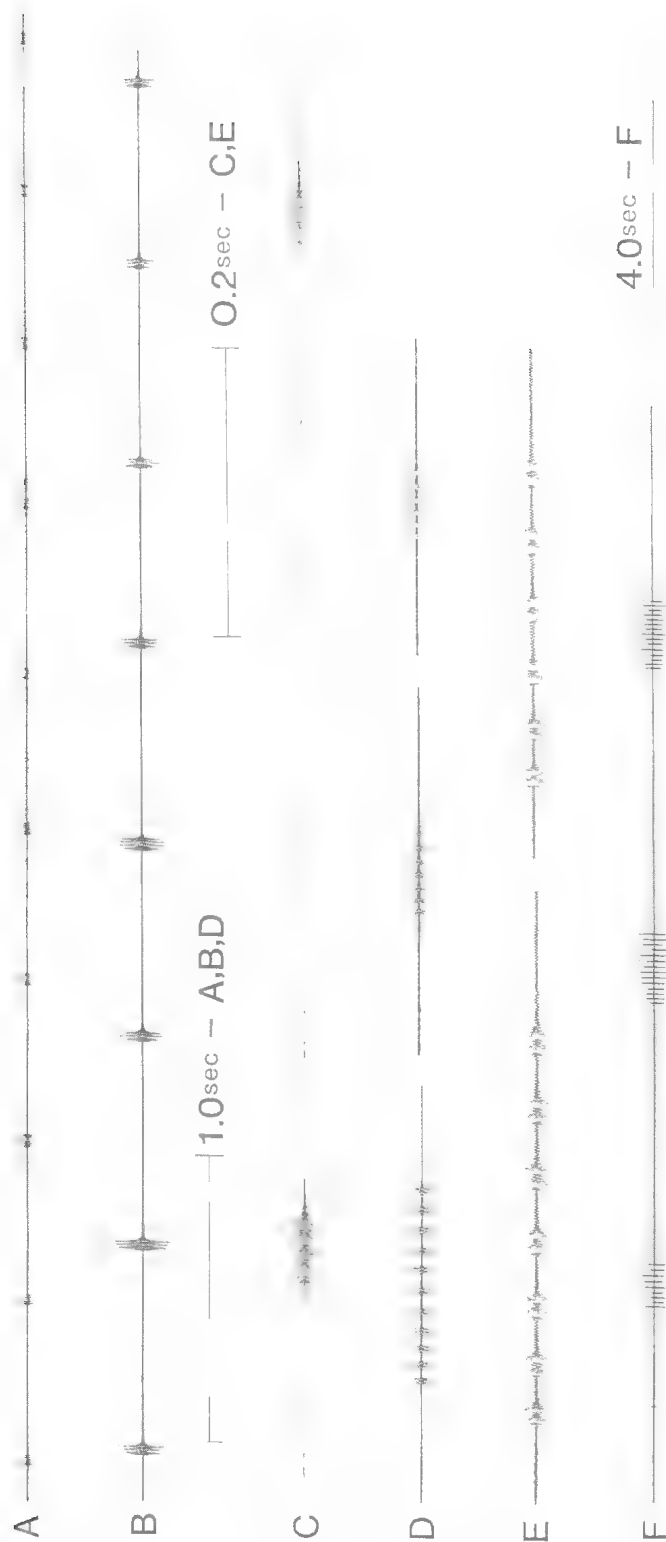


FIG. 27. Oscillograms of three sets of calling songs of *P. siccanus*. A to C, near Wyseby, Rolleston-Injune road (December, 1985). A; recorded in field; B, C, recorded in captivity. A and B (representing separate specimens) are shown at the same time scale. D and E, Lake Broadwater (30 km SW Dalby; Dec. 1988; two different time scales). F, 15 km E of Narrabri, base of Nandewar Ranges (December 1971; JM).

Wyseby (Injune-Rolleston road), to Amby and Augathella, and southeast to near Dalby and Yelarbon (near Goondiwindi) (Fig. 57). In New South Wales, it has been collected only from the base of the Nandewar Ranges, near Narrabri. The preferred habitat is dry, open, eucalyptus-casuarina-callitris mixed woodland. It appears to be localised in these areas.

SONG

The calling song consists of a continual series of short 'chirps' (Fig. 27). The oscillograms show it to comprise distinct and separate phrases, the detailed structures of which exhibit distinct regional variations, detailed as follows:

Wyseby song (Fig. 27A-C): Each phrase consists of between 3 to 6 discrete pulses (each a compound pulse group). The time intervals between phrases, measured for two songs from separate insects, are 0.52-0.59 (mean 0.55) and 0.61-0.73 (mean 0.67) sec. The total duration of each pulse group is 30-40 msec, with mean intervals of 8 and 11 msec between pulses measured on the two separate songs. Expanded time scale oscillograms show that each compound pulse group is preceded by an additional small amplitude single pulse, with a 2 msec interval.

Lake Broadwater song (Fig. 27D-E): Phrase lengths vary between 0.2 to 0.7 sec, while interphrase intervals are variable (approximately 1 to 15 sec). Each phrase comprises clearly defined double pulses (each a compound pulse group), with between 6 to 11 doublets per phrase; the phrases, therefore, are markedly longer than observed for the Wyseby specimens (confirmed by additional field aural observations). Intervals of 8-10 msec occur between each pulse group comprising the pulse doublets, while intervals between the double pulses progressively increases from 24 to 38 msec during the emission of each phrase. The detailed structure of each pulse group is similar to the Wyseby song, each of 30-40 msec duration, and each also preceded (by approximately 2 msec) by an additional small amplitude single pulse.

A single song record from the base of the Nandewar Ranges (Fig. 27F) is very similar to the Lake Broadwater *P. siccanus* song.

Pauropsalta aktites n.sp. (Figs 28, 29, 32E, F, 57)

MATERIAL EXAMINED

HOLOTYPE: ♂ QUEENSLAND, Southport Spit, SEQ, 12.iii.1978, A. Ewart (QM, Reg. No. T.9188).

PARATYPES: QUEENSLAND: 1♂, 1♀, Southport Spit, 12.iii.1978, A.E. (ANIC). 1♂, 1♀, Southport Spit, 12.iii.1978, A.E. (BMNH). 1♂, 1♀, Beach, Mon Repos, Bundaberg, 30.i.1983, A.E. (MNDN). 1♂, Brisbane, 16.x.1911, H. Hacker; 1♂, Brisbane, 15.ii.1916, H. Hacker; 1♀, Brisbane, 10.x.1917, H. Hacker (QM). 1♂, N Stradbroke Is., 1.iii.1980, H.E. and M.A. Evans and A. Hook Coll. (UQIC). 2♀♀, 3♀♀, Fraser Is., 22.i.1973, J.T. Moss; 1♂, Great Keppell Is., 4.xi.1983, J.T. Moss; 1♀, Hervey Bay, 8.i.1972, J.T. Moss; 1♀, Hervey Bay, 9.iii.1980, J.T. Moss (JM). 4♀♀, 1♀, Double Island Pt nr Tin Can Bay, 19.x.1986, R. Eastwood; 1♀, Eurong, Fraser Is., 4-14.xii.1977, A.E.; 1♂, Golden Beach, Caloundra, 18.xi.1979, A.E.; 2♀♀, L. Freshwater, S of Rainbow Beach nr Gympie, 12.xi.1982, G. Theischinger; 1♂, Tugun, nr Coolangatta, 8.x.1967, J. North (MSM). 2♀♀, Beach between Amity and Pt Lookout, Stradbroke Is., 10-11.i.1981, A.E.; 1♀, coastal dunes, Bribie Is., 20.i.1977, A.E.; 1♂, Coast, Bribie Is., 14.ix.1980, A.E.; 1♂, Caloundra, 29.ix.1979, A.E.; 11♀♀, 1♂, Beach front, Eurong, Fraser Is., 4-14.xii.1977, A.E.; 1♂, Golden Beach, Caloundra 21.x.1979, A.E.; 2♀♀, 28.x.1979, 1♂, 25.xi.1979, 3♀♀, 5.ii.1981; 1♀, 1♀, Labrador, nr Southport, iv.1976, A.E.; 17♀♀, 6♀♀, Beach, Mon Repos, nr Bundaberg, 30.i.1983, A.E.; 2♀♀, N Stradbroke, 18.xi.1972, A.E.; 2♀♀, N end of S Stradbroke Is., 4.xii.1971, A.E.; 1♂, iv.1975; 8♀♀, Southport Spit, 12.iii.1978, A.E.; 3♀♀, 1♀, 23.iv.1978, 1♂, 7.v.1978; 2♀♀, 1♀, S end Southport Spit, 5.ii.1987, A.E.; 2♀♀, Teewah beach front, 15.xii.1978, A.E.; 2♀♀, Waddy Pt, Fraser Is., in Casuarina sp., 15.xii.1977, A.E. (AE). NEW SOUTH WALES: 1♂, Avalon Beach, Sydney, 17.xii.1958, M.S. Moulds (QM). 1♂, 35.58S 150.09N, Congo, 8 km SE by E of Moruya, 18.xii.1981, M.S. Upton; 1♂, Crookhaven, 31.xii.1933, Fuller; 1♂, Cronulla, 19.xi.1968, J.T. Moss, 3♀♀, 29.xi.1970; 2♀♀, 1♀, Currarong Bch, 22.i.1966, J.T. Moss; 1♂, Durras, dunes behind beach, 1.ii.1973, D.H. Colless; 3♀♀, Elizabeth Bch, 9.xi.1969, J.T. Moss; 1♀, Evans Head, 27.i.1985, J.T. Moss; 1♂, 1♀, Port Macquarie, 2.xi.1984, J.T. Moss (JM). 1♂, Avalon Beach, Sydney, 4.xii.1958, M.S. Moulds, 21♀♀, 1♀, 17.xii.1958, 2♀♀, 18.i.1960, 2♀♀, 29.xii.1961, 1♂, 1.i.1962, 1♂, 29.xii.1969; 1♀, Avoca Beach, i.1980, S. Hunter; 3♀♀, Blackhead, nr Taree, 7.i.1972, M.S. Moulds; 1♂, 1♀, Bonny Hills, 24.xi.1980, swept from *Acacia longifolia*, G. and T. Williams; 2♀♀, Boomerang Beach nr Wallis L., 9.i.1972, M.S. Moulds; 2♀♀, Broken Head nr Byron Bay, 24.xii.1975, G. Daniels; 1♂, c. 1.5 km SW Crowdy Head, 21.x.1985, G. Williams, ex beach hind dune zone; 1♀, Culburra, 6.i.1986, S. and B. Underwood; 2♀♀, 1♀, Dee Why Lagoon, 5.i.1972, J.V. Peters; 2♀♀, Forster, 15.i.1971, G.R. Brown; 5♀♀, Forster, 6.i.1972, M.S. Moulds; 1♂, 6 km N of Harrington, 19.i.1981, on *Acacia longifolia* on beach dune, G. and T. Williams, 1♂, 1♀, 12.xi.1981; 1♀, Harrington, 24.ii.1981, G. and T. Williams; 1♀, c. 3 km N of Harrington, 8.xi.1982, on *Acacia longifolia* var. *sophorae* foliage; in cleared open area adjoining littoral rainforest and melaleuca swamp, G. and T. Williams; 1♂, Harrington, 8.ii.1983, on *Acacia longifolia*, G. and T. Williams; 1♂, 2-3 km N of Harrington, 9.x.1983, on

Acacia longifolia var. *sophorae* foliage, G. Williams; 3♂♂, L. Cathie, 24.xi.1980, swept from dune vegetation on beach, G. and T. Williams; 1♂, c. 3 km N of Laurieton, 2.x.1983, on *Acacia longifolia* var. *sophorae*, on beach hind dunes, G. Williams; 1♂, Mainbar, 7.xii.1967, A.D. Cliff; 2♂♂, Manning Pt, E of Taree, 9.xi.1982, on *Acacia longifolia* var. *sophorae* on foredune of beach, G. and T. Williams; 1♂, Manning Pt, c. 12 km E Taree, 23.xii.1982, beaten from foliage in littoral rainforest-foredune vegetation interface, G. and T. Williams; 1♂, Manning Pt, E of Taree, 10.xi.1983, on littoral rainforest margin, G. and T. Williams; 1♂, Norah Head, 1.i.1972, G. Daniels; 9♂♂, 2♀♀, Ocean Beach, Umina, 5.xii.1977, M.S. and B.J. Moulds; 4♂♂, 2♀♀, Old Bar, nr Taree, 8.i.1972, M.S. Moulds; 1♀, Old Bar, 9.xi.1983, ex *Jacksonia* dom. shrub assoc., G. Williams; 1♂, Sandhills, Palm Beach, 10.i.1970, J.V. Peters; 6♂♂, Port Macquarie, 10.i.1972, M.S. Moulds; 1♀, Urunga, 23.i.1971, M.S. Moulds; 2♂♂, Wattamulla, 24.xi.1968, G.R. Brown; 1♂, Wooli, 28.x.1962, M.S. Moulds. (MSM). 1♂, Hastings Pt, 6.x.1979, A.E. (AE).

ETYMOLOGY

Derived from the Latin *aktites* meaning shore or coast dweller.

DESCRIPTION

MALE: **Head:** Black with brown to reddish-brown markings. Postclypeus black anteriorly with reddish-brown margin, extending into grooves between transverse ridges; median brown area occurs dorsally on midline; silver pubescence between transverse ridges; dorsal surface black. Anteclypeus black with silver-white pubescence. Rostrum pale brown adjacent to anteclypeus, grading to black apically, and extending to mid coxae. Gena and mandibular plate black with conspicuous silver pubescence. Antennae black. Ocelli deep pink to red (apparently fading in some preserved specimens). Eyes medium brown with silver-white pubescence in region behind the eyes. Dorsal surface of head black with brown markings on anterior edge adjacent to postclypeus; short, sharply pointed, longitudinal sandy-brown fascia extending between lateral ocelli and posterior margin of head; gold-brown pubescence present, extending to dorsal surface of postclypeus. Vertex lobes black.

Thorax: Pronotum black with sandy-brown central fascia; pronotal collar medium brown; anterior margin, adjacent to head, dark to medium brown; short gold-yellow pubescence, particularly evident adjacent to oblique fissures.

Mesonotum black with sandy-brown dorsolateral fasciae which broaden dorsally towards each other midway along mesonotum, and which extend to the cruciform elevation.

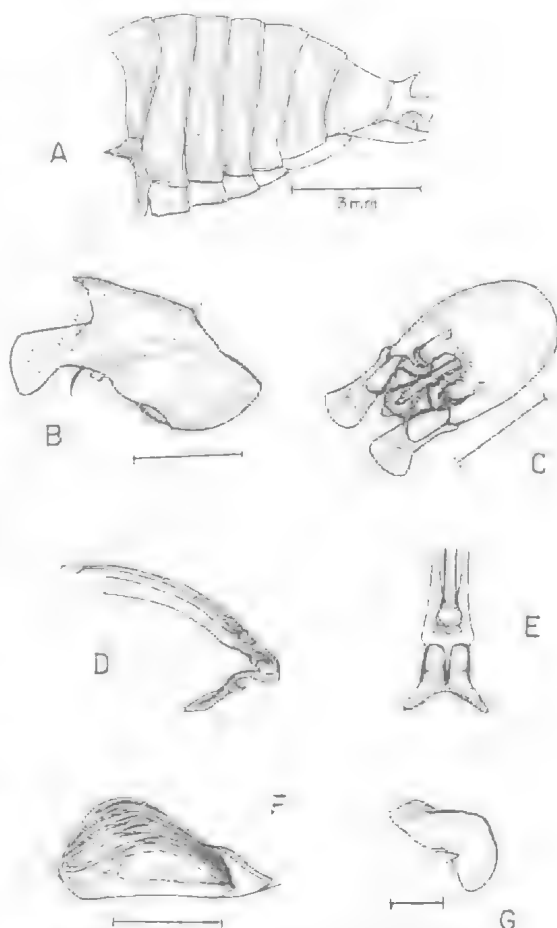


FIG. 28. *Pauropsalta aktites* sp.n., ♂, from Southport Spit, southern coastal Queensland, Symbols A to G, and scales, as in Fig. 2.

Cruciform elevation black anteriorly, becoming sandy-brown medially and posteriorly; sandy-brown colouration and silver pubescence extend along wing grooves and adjacent ridges; silver pubescence around cruciform elevation.

Legs: Coxae dark and medium brown; femora sandy-brown with longitudinal, broad, dark brown fasciae; fore tibiae and tarsi, and spines of fore legs dark brown; mid and hind tibiae and tarsi paler; claws dark brown.

Wings: Fore wing venation medium to dark brown, becoming darker distally towards apical cells and ambient veins, except the fore wing vein R+Sc which is notably paler; very faint infuscation along CuA₂ vein, proximally to join with vein 1A+2A; faint infuscation spot on hind wings, and also adjacent to plaga; slight angulation of fore wing at node.

Tymbals: Dorsal ridge extends across dorsal

inter-ridge sclerite; two lower ridges are joined anteriorly; small basal spur.

Opercula: Roughly sickle-shaped, broadly rounded apically; declivous flange most conspicuously developed along outer anterior margin; colour deep brown anteriorly grading outwards to sandy-brown in posterior region; surface appears finely rugose and is sparsely covered by silver pubescence; anterior central area broadly domed; posterior region somewhat longitudinally undulate (i.e. parallel to body axis).

Abdomen: Black pigmentation along anterior region of each tergite; tergites 2 to 8 exhibit a conspicuous reddish-brown zone extending around and adjacent to the posterior margins of each tergite (extending only dorsolaterally in tergite 2) and becoming broader towards tergite 8; posterior margins of tergites orange to yellow-brown. Sternites II brown; sternites III to VII reddish brown with irregular, patchy, and slightly darker markings, and a weakly developed (or absent) median darker region; posterior margins of sternites orange to yellow-brown; sternite VIII orange-brown. Silver pubescence generally conspicuous on lateral and dorsolateral areas of tergites, becoming more medially conspicuous on tergite 8; in some specimens, the silver pubescence also extends medially along all tergites, giving the appearance of a narrow dorsal abdominal stripe, tapering posteriorly.

Genitalia: Pygophore medium brown; somewhat ovoid in shape when viewed ventrally; upper lobes enlarged distally, with partially hook-like and relatively acute termination; spur-like structure extending from inner lobes is curved; claspers terminate apically with a hooked structure; endotheca slightly curved; bifid pseudoparameres are sharply tapering and curved apically; pseudoparameres join endotheca close to gonocoxite IX.

FEMALE: General markings and colouration closely similar to male. Ocelli deep pink. Pronotum exhibits pale sandy-brown area around posterior termination of central fascia, and adjacent to anterior oblique fissures. Mesonotum with dorsolateral brown fasciae broadened so as to join medially. Tergites with reddish-brown zones around posterior margins more extensively developed, and only minor black colouration on tergite 8; silver pubescence more extensively developed; tergite 9 medium brown with a pair of dorsolateral black fasciae extending three-quarters of the tergite length towards the posterior edge; ovipositor sheath does not extend beyond termination of tergite 9.

MEASUREMENTS: 46♂♂ and 13♀♀. Body length: ♂ 11.7-14.5 (13.28); ♀ 13.0-14.7 (13.76). Fore wing length: ♂ 14.0-17.3 (15.63); ♀ 15.2-17.3 (16.31). Head width: ♂ 3.8-4.5 (4.13); ♀ 4.3-4.6 (4.44). Pronotum width: ♂ 3.4-4.2 (3.73); ♀ 3.8-4.2 (4.04). Abdomen width: ♂ 3.6-4.5 (3.99); ♀ 3.7-4.2 (3.95).

COMMENTS

This species is similar to *P. rubea* (see following description), although their habitats do not normally overlap. Useful distinguishing male features include the intensity of the hind wing infuscation (conspicuous in *P. rubea*; weak in *P. aktites*) and the intensity of the black longitudinal fascia ventrally along the abdomen (distinct in *P. rubea*; weak to absent in *P. aktites*).

DISTRIBUTION

Southern New South Wales coast from Congo northwards to Great Keppel Island, central Queensland coast (Fig. 57). Confined to coastal vegetation on, and immediately behind, the strand and foredune complex (most commonly in *Casuarina equisetifolia*) usually within a 50 m strip but may extend for up to 200 m inland. The adults are active from September to May.

SONG

The song pattern consists of two regularly repeated phrases, an initial short followed rapidly by a long phrase, all of similar amplitude (Fig. 29). The song pattern may be modified by the insertion of an additional short phrase immediately preceding the long phrase (Fig. 29A-C), but even in the individual insect from which these oscillograms were produced (from Southport), the additional phrase was not always present. Similarly, Fig. 29E shows both the presence and

TABLE 2. Comparative data on calling song patterns of *P. aktites*.

Part of Song Pattern	Location		
	Southport	Cooloola	Bundaberg
(a) Duration of short phrase (msec)	av. 34.5 (31-41)	av. 32.6 (30-40)	av. 31.1 (30-38)
(b) Duration of long phrase (sec)	av. 1.44 (1.34-1.48)	av. 1.19 (1.10-1.29)	av. 0.95 (0.83-1.0)
(c) Duration between long phrases (sec)	av. 0.44 (0.40-0.47)	av. 0.26 (0.25-0.28)	av. 0.32 (0.29-0.36)
(d) Duration between short and following long phrases (msec)	av. 58 (51-62)	av. 25 (26-40)	av. 34 (25-38)

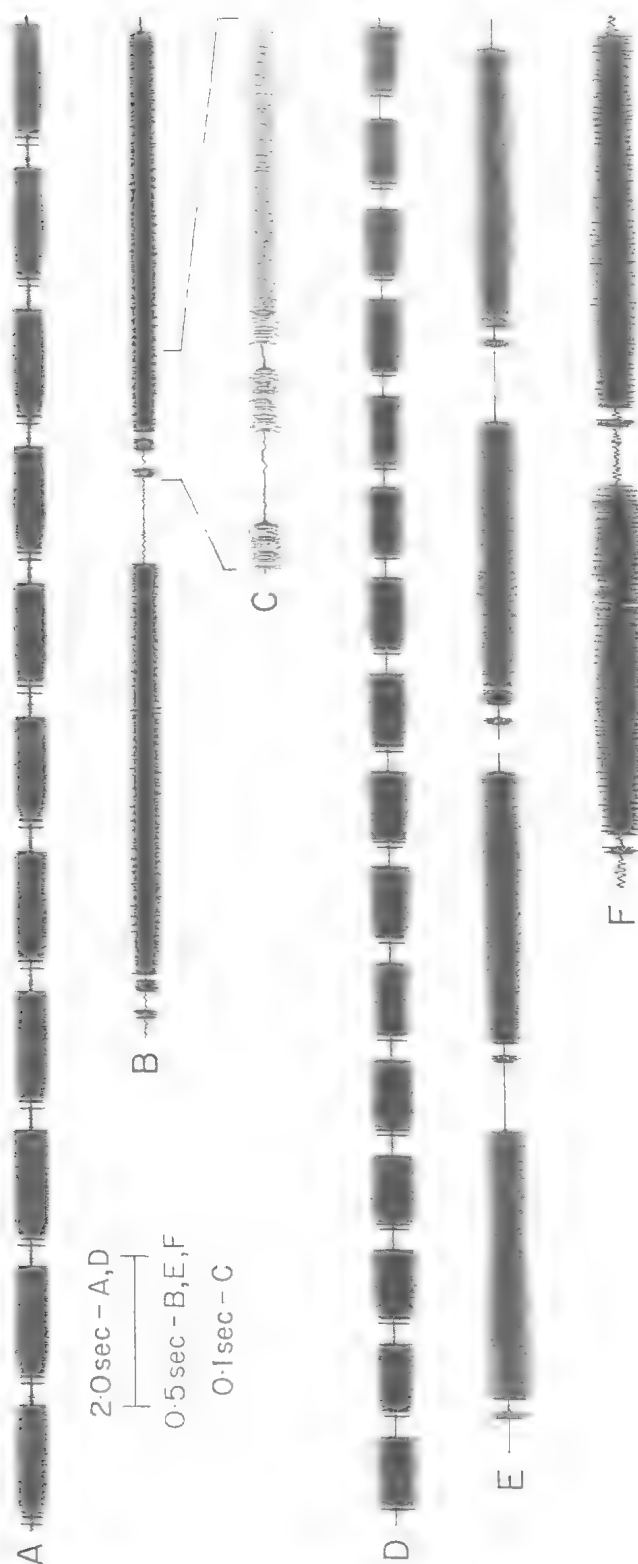


FIG. 29. Oscillograms of three sets of calling songs of *P. aktites*. A to C, Southport Spit (March, 1978); D, E, Mon Repos, near Bundaberg (Jan. 1983); F, Teewah, Cooloolah (Dec. 1978). Three different time scales are shown.

absence of the additional phrase from a Cooloola specimen.

Table 2 gives detailed durations of the song pattern, based on songs from three widely separated localities, parts of which are illustrated in the oscillograms (Fig. 29). These data suggest significant intra-specific song variability. On an expanded time scale, the songs are resolved into relatively high amplitude compound pulse groups, with a repetition frequency between 385-420 Hz, these superimposed on a background of low amplitude higher frequency pulse groups.

***Paurosalta rubea* (Goding and Froggatt)
n.comb.
(Figs 30,31,32C,D,58)**

Melampsalta rubea Goding and Froggatt, 1904:651; Distant, 1906b:176; Burns, 1957:661; Duffels and van der Laan, 1985:291.

Cicadetta rubea (Goding and Froggatt) Kirkaldy, 1907:309; Metcalf, 1963:374; Dugdale, 1972:879.

Melampsalta geisha Distant, 1915:50,51; Burns, 1957:653; Duffels and van der Laan, 1985:285. *N. Syn.*

Cicadetta geisha (Distant) Metcalf, 1963:315.

MATERIAL EXAMINED

LECTOTYPE: ♂ of *Melampsalta rubea*, here designated, in ANIC. *Melampsalta rubea*, G. and F. ♂. Brisbane, Queensland; ex MM, and 'on permanent loan' to ANIC.

PARALECTOTYPE: ♀ from the same locality and has an additional label 'Brisbane, Dec. 1903 (J.B.)', ANIC.

HOLOTYPE: ♀ of *Melampsalta geisha* in BMNH: Stradbroke Is.: H. Hacker, 5.12.13 (the date being handwritten). Two additional labels give the number '8', and the numbers '19.14.346'. The accessions catalogue indicates that the latter refer to '18 cicadas, 100 Hymenoptera, Australia. Sent in exchange by the Brisbane Museum, Queensland 17.7.14 (25.ix.14)'.

OTHER MATERIAL: 20♂♂, 29♀♀ from following localities. **QUEENSLAND:** Brisbane; Fraser Is., Bob Gully; Kroombit Tops (upper Kroombit Ck), 45 km SSW Calliope; Stradbroke Is. (QM). Rockhampton (UQIC). Blackdown Tableland; Ewan Rd, 3-14 mi. W of Paluma; 7 km S Herberton; Kondalilla Falls, via Mapleton; L. Elphinstone, nr Glendon; 7 mi. W of Paluma, 3000 ft; 9 mi. W of Paluma, 2500 ft; Prince Henry Heights, Toowoomba, 620 m; Rainbow Beach; Roundhill Hd, nr Town of 1770 (JM). Coomanglah Range, 20 km NW of Monto; Wallaville (MSM). Blackdown Tableland; S end of L. Cootharaba; St Lucia, Brisbane (AE). **NEW SOUTH WALES:** Newport (Sydney) (MV). Berowra Waters, Hawkesbury R.; Palm Beach (Sydney); Wollombi (on Wisemans Ferry to Singleton Rd) (JM). Avalon Beach, Sydney; Failford, nr Taree; 1-2 km N of Kew, dry scler. forest; Old Bar, Jacksonia dominated shrub assoc.; c. 2 km SW Old Bar via Taree; cent. sect. Yarratt S.F., NE Wingham, dry scler. forest (MSM).

DESCRIPTION

MALE: *Head:* Postclypeus; anteriorly black with broad, pale brown margin; greenish, spindle-shaped fascia along lower third of midline, and a round greenish spot dorsally on midline, which extends on to dorsal surface; silver-yellow pubescence present, especially along grooves between transverse ridges; dorsal surface mainly black with short yellowish pubescence. Anteclypeus shiny black with conspicuous silver pubescence. Rostrum pale brown, becoming darker apically, and extending between mid and hind coxae. Mandibular plate black with long silver pubescence. Gena mainly black, becoming brown adjacent to eyes, and covered by silver pubescence; suture between gena and mandibular plate pale brown, extending along lateral clypeal clefts. Antennae deep brown, becoming pale

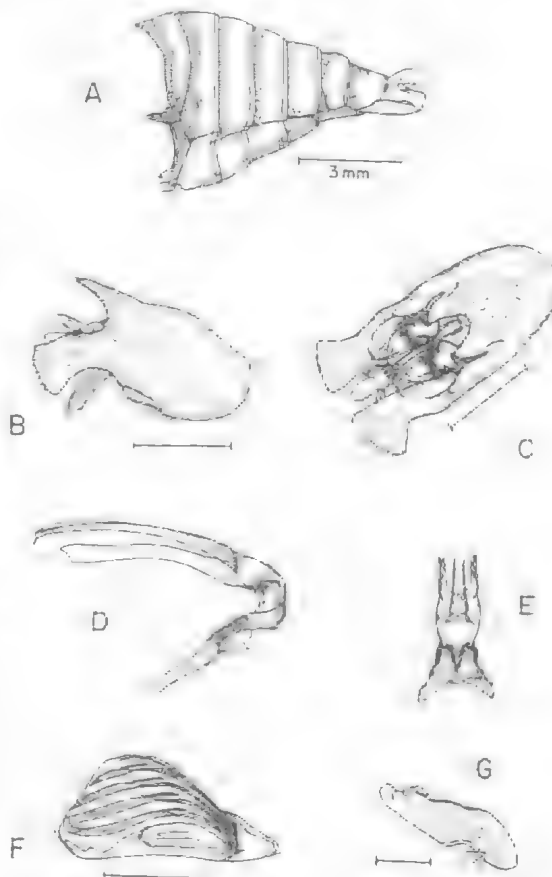


FIG. 30. *Paurosalta rubea* (Goding and Froggatt) comb.n., ♂, from southern end of Lake Cootharaba, southern Queensland. Symbols A to G, and scales, as in Fig. 2.

brown apically. Ocelli cherry-red. Eyes dark brown (mottled in some dried specimens). Dorsal surface of head black, becoming brown adjacent to posterior margin of head; pale green triangular cleft, anteriorly pointing, situated between the ocelli, and extending to posterior edge of head; short yellowish pubescence, most conspicuous behind eyes. Vertex lobes greenish-brown.

Thorax: Pronotum pale reddish-brown, with pale greenish-brown, broad central fascia which narrows posteriorly, but widens abruptly into an outward pointing, wedge-shaped pattern (with small median black spot) adjacent to pronotal collar; irregular and broken black markings along and between the oblique fissures; pronotal collar pale brown; short silvery-yellow pubescence.

Mesonotum pale greenish-brown with irregular triangular-shaped lateral fasciae, which broaden anteriorly adjacent to pronotal collar; broad obconical dorsolateral black areas adjacent to pronotal collar; cruciform elevation pale green medially, pinkish-brown along radiating arms, black laterally and anteriorly between arms; silver-yellow pubescence especially conspicuous around cruciform elevation, and adjacent to wing grooves.

Legs: Fore and mid coxae predominantly black on inner and anterior margins, brown on outer margins; hind coxae black; silver pubescence conspicuous; fore femora black on inner margins, with longitudinal, broad, black and brown fasciae on outer margins; mid and hind femora medium brown with single black longitudinal fascia on anterior margins; fore tibiae and tarsi dark brown, becoming progressively paler on the mid and hind legs respectively; spines and claws dark brown.

Wings: Venation of fore wings reddish-brown, dark brown along anterior edge of costal veins; pterostigma reddish-brown; venation of hind wings brown, with infuscation spots dark brown and clearly visible.

Tymbals: Dorsal ridge extends across dorsal inter-ridge sclerite; the two lower ridges joined anteriorly; distinct basal spur.

Opercula: Roughly sickle-shaped, obliquely elongated; central region shiny, domed, dark brown; posterior region pallid; declivous flange along outer margin; broadly longitudinally undulate (i.e. parallel to body axis).

Abdomen: Each tergite with black anterior band passing irregularly to reddish-brown colouration which covers the dominant areas of tergites, and increases in extent towards tergite 8; tergite posterior margins pale green; short silver pubescence present, especially dorsolaterally and laterally on all tergites, and also dorsally on

tergites 2 and 3. Sternites III to V yellow brown to reddish-brown, with diffuse dark grey to black median region which broadens progressively towards sternite VI, and extends across much of sternite VII; sternite VIII, medium brown; sternite II predominantly dark grey; short silver pubescence present.

Genitalia: Colour reddish-brown grading irregularly to black anteriorly; upper pygophore lobes slightly decurved, somewhat flattened along distal margin, and asymmetrically acute; lower lobes tapering, rounded apically, and posteriorly pointing; claspers contain a pair of hooked processes; aedeagus with dorsal pseudoparameres, apically acute and tapering, which join the endotheca near gonocoxite IX.

FEMALE: General colouration and patterning similar to male, but with less black colouration. Head: Postclypeus brown with ventral and dorsal pale green to brown areas along midline; dorsolateral black colouration reduced compared to male, although more extensive along transverse ridges; dorsal surface pale brown; dorsal surface of head medium brown marginally, with central irregular black area enclosing ocelli, and pallid depressed fascia or suture extending from between ocelli to posterior margin of head; vertex lobes pale brown. Pronotum as in male, with reduced area of black markings. Mesonotum: Black dorsolateral and lateral fasciae reduced in extent compared to male, the main colouration being pale brown; cruciform elevation pink to pale brown with black markings extending around anterior and lateral margins. Legs similar to male, with reduced black and increased brown colouration on coxae and femora. Abdomen: Tergites predominantly reddish-brown with very narrow darker anterior markings which extend dorsally to laterally on tergites 2 and 3, but only dorsally on tergites 4 to 7; tergite 8 reddish-brown grading to pale brown posteriorly; tergite 9 pale brown with indistinct dorsolateral fasciae; posterior margins to tergites pale greenish-brown. Sternites reddish-brown to brown, with deep brown to black broad median fascia, interrupted by pale sandy-brown posterior margins of sternites; ovipositor sheath does not extend significantly beyond termination of tergite 9.

MEASUREMENTS: 12♂♂ and 9♀♀. Body length: ♂ 13.5-16.0 (14.87); ♀ 14.5-16.5 (15.47). Fore wing length: ♂ 17.3-20.0 (18.46); ♀ 17.8-20.0 (18.72). Head width: ♂ 4.4-5.3 (4.78); ♀ 4.6-5.2 (4.93). Pronotum width: ♂ 3.7-4.6 (4.08); ♀ 3.7-4.4 (4.11). Abdomen width: ♂ 4.0-4.8 (4.31); ♀ 3.9-4.3 (4.10).

COMMENTS

A matching female specimen to the type of *M. geisha* is held in QM with the following labels: 'Stradbroke Island H. Hacker 5.12.13'; 'Ho/2649'; '8'; 'Type series'; '*Melampsalta geisha* Distant'. The original description of *M. rubea* clearly refers to both a male and female pair from Brisbane, although only the female paralectotype bears a Brisbane locality label. The original description corresponds to the two specimens, especially in regard to their relatively strong red colouration which suggests fresh emergence when captured. They are thus interpreted as the syntypes. Examination of the types of *M. rubea* and *M. geisha* indicates that they are conspecific, and were in fact, collected from very close locations.

This species is close to *P. aktites*, and distinguishing features have been previously listed. Another similar species is *P. marginata* and both species occurring in similar and often overlapping habitats; song patterns are quite distinct. Distinguishing features are the relative lengths of the dorsal tymbal ridges in males (short, not extending across dorsal inter-ridge sclerite in *P. marginata*; longer, extending across dorsal inter-ridge sclerite in *P. rubea*); in females of *P. marginata*, the ovipositor sheath extends 3-4mm beyond termination of tergite 9, whereas in females of *P. rubea*, the ovipositor sheath does not extend significantly beyond tergite 9.

DISTRIBUTION

Eastern Australia, from Sydney to near Herberton in northern Queensland (Fig. 58). The apparent gap between the central New South Wales and southern Queensland regions probably reflects lack of collecting. Through much of its range, it occurs locally and relatively sparsely in tall open dry forest where the males are heard, but rarely caught or seen. It normally prefers the higher and outer canopy of the forest, rarely found low down, except for ovipositing females. It does, however, occur in the dry forest and scrub communities of the coastal lowlands, and dune complexes as on North Stradbroke and Bribie Islands (immediately inland of the zone in which *P. aktites* occurs). It appears to prefer more elevated environments in the northern part of its range. It occurs from October to April.

SONG

A regularly repeated sequence of phrases, all of approximately constant amplitude, four (or less commonly five) in number (Fig. 31). The duration

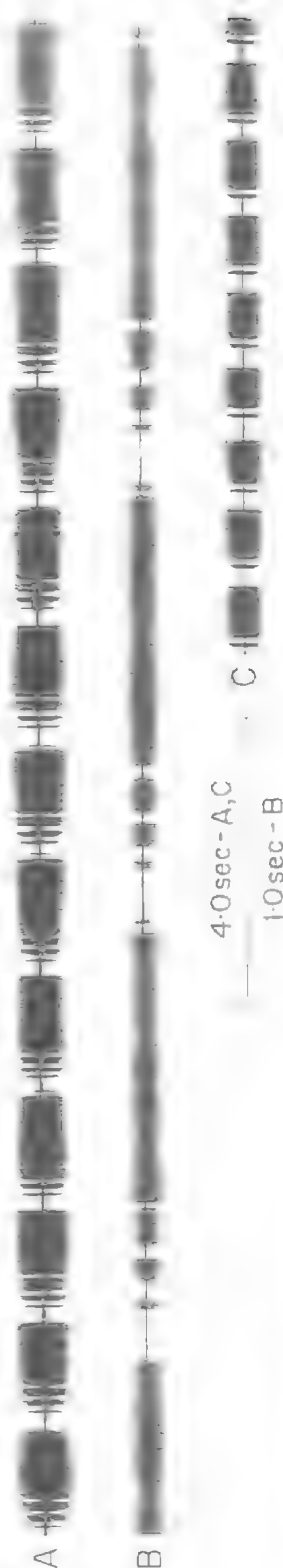


FIG. 31. Oscillograms of calling songs of *P. rubea* from: A, B, North Stradbroke Island, southern Queensland (Jan, 1981); C, Wollonbi, New South Wales (Dec. 1971; JM). Records shown at two time scales.

of each phrase progressively increases in length, the final phrase being relatively long, with a duration of 0.78-1.09 sec. Intervals between these final long phrases vary between 0.5-0.78 sec. The intermediate shorter phrases have average durations of 28, 42, 93, to 133 msec, as the song progresses, respectively. The pulse structure of the whole song pattern is similar, being composed of very closely spaced, and overlapping composite pulse groups, with estimated durations of 10-11 msec. In Figure 31, the Stradbroke Island song is compared with one recorded at Wollombi, New South Wales (JM). The latter song comprises a short phrase (approximately 72 msec duration) followed, after a pause of similar duration (70 msec), by a long phrase (average duration 0.59 sec), with the duration between long phrases averaging 0.38 sec. This song thus differs in detail from the S Queensland song pattern, although the insects are morphologically very similar, suggesting regional song variability.

***Pauiropsalta marginata* (Leach) n.comb.
(Figs 32A, B, 33, 34)**

- Tettigonia marginata* Leach, 1814:89, Pl.39, fig.1.
Cicada marginata (Leach) Walker, 1850:173, Dohrn, 1859:74.
Cicada themiscura Walker, 1850:177, 178; Dohrn, 1859:74; synonymized by Distant, 1906b:170.
Melampsalta marginata (Leach) Stål, 1861:619; Goding and Froggatt, 1904:646; Ashton, 1912c:80; Ashton, 1914:353; Hardy 1918:71; Kato, 1932:187; Burns, 1957:657; Duffels and van der Laan, 1985:287.
Melampsalta themiscura (Walker) Stål, 1862:484; Distant, 1882:130.
Melampsalta fletcheri Goding and Froggatt, 1904:640, 641; Distant, 1906b:176; synonymized by Ashton, 1912c:80.
Cicadetta marginata (Leach) Kirkaldy, 1907:308; Metcalf, 1963:329, 330; Dugdale, 1972:877; Ewart, 1986:51, 54, fig. 3c; Ewart, 1988:182, figs 9F, G, Pl. 1E.
Cicadetta fletcheri (Goding and Froggatt) Kirkaldy, 1907:309.

MATERIAL EXAMINED

HOLOTYPE: ♂ of *Tettigonia marginata*, HEC (Hem. Type 784) (Ewart, in press); 'Marginata L.Z39.NH'. This is interpreted as L = Leach; Z = Zoological Miscellany; 39 = Plate 39; NH = New Holland.

HOLOTYPE: ♂ of *Cicada themiscura* in BMNH: No locality data.

HOLOTYPE: ♂ of *Melampsalta fletcheri* in MV: New South Wales; Goding Type, det. by Goding 10-04.

OTHER MATERIAL: 80♂♂, 60♀♀ from following localities. QUEENSLAND: Brisbane (BMNH). Brisbane (MV). Brisbane; Stradbroke Is (QM). Biggenden; Blackdown Tableland; Caloundra; Hervey Bay; Mt

Walsh N.P., Bluff Range, 1000 m; Pomona (JM). Amity swamp, N Stradbroke Is.; Beerburrum; Blackdown Tableland; Boolimba Bluff, Carnarvon N.P.; Caloundra; Doolandella, Brisbane; Kroombit Tops, Dawes Range; L. Broadwater, nr Dalby; Mt Moffatt N.P. (AE). NEW SOUTH WALES: Sydney (BMNH). Broadwater N.P., via Evans Head; Howes valley, Putty Rd; Mt Loftus, nr Sutherland; Mulgoa, nr Penrith (JM). Doyalson, nr Morrisset; Loftus (AE).

DESCRIPTION

MALE: Head: Postclypeus shiny black anteriorly with a relatively narrow reddish-brown outer margin, and a dorsal median brown spot on midline extending to dorsal surface; sparse silvery-gold pubescence, especially in grooves between transverse ridges; dorsal surface predominantly black. Anteclypeus black with prominent silver pubescence. Rostrum medium brown, becoming darker apically; extends to mid coxae. Gena and mandibular plate black with prominent silver pubescence. Antennae dark brown. Ocelli pink-brown. Eyes medium brown. Dorsal surface of head black with fuscous triangular area between ocelli, anteriorly pointing and extending from posterior margin of head; golden pubescence especially prominent behind eyes. Vertex lobes reddish-brown.

Thorax: Pronotum black with lanceolate-shaped pale brown central fascia, and dorsolateral pale brown wedge-shaped fasciae adjacent to reddish-brown to brown pronotal collar; short golden pubescence mainly concentrated in dorsolateral and lateral region.

Mesonotum: Broad, black lateral and dorsolateral fasciae; black median fascia coalescing anteriorly with dorsolateral fasciae, and posteriorly broadening adjacent to cruciform elevation; remaining area pale pink-brown to medium brown; silver-gold pubescence especially prominent around cruciform elevation and along wing grooves and adjacent ridges.

Legs: Coxae black with brown longitudinal fasciae along margins of fore coxae; femora medium brown with dark brown longitudinal fasciae; fore and mid tibiae and tarsi brown, being somewhat paler on hind legs with darker longitudinal fasciae; claws and spines dark brown to black.

Wings: Fore wings with dark brown venation, except very pale along costal vein, and pale pink-brown R+Sc and Sc veins; pterostigma black; extremely faint infuscation along CuA₂ vein close to join with 1A+2A vein; small but clearly defined infuscation spots on hind wings.

Tymbals: Dorsal ridge does not extend across

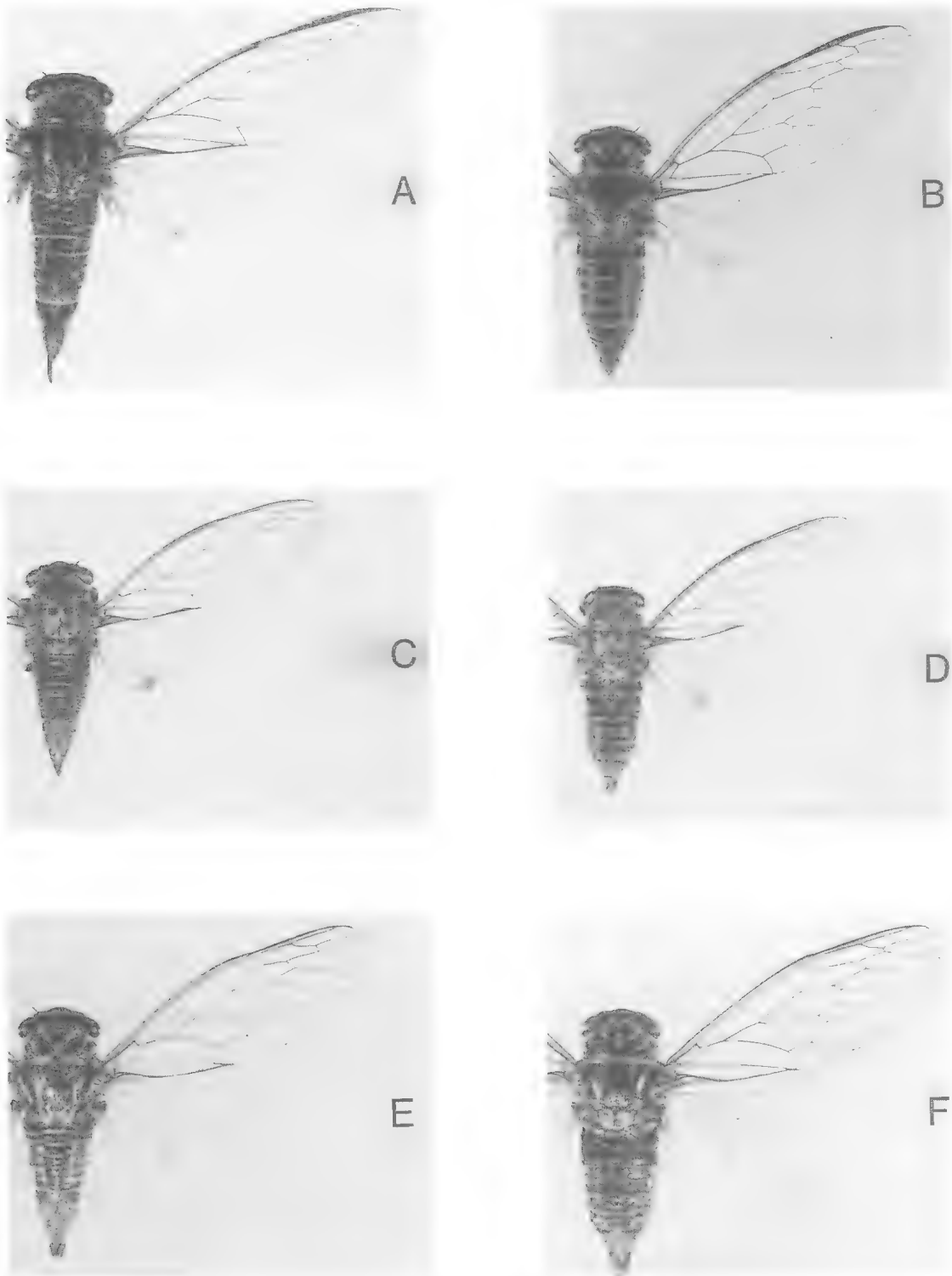


FIG. 32. A,B *P. marginata* ♀, ♂. C,D *P. rubea* ♀, ♂. E,F *P. aktites* ♀, ♂. Photographs A to D $\times 2$ natural size; E,F $\times 2.7$ natural size. Photographs: D.M. Reeves.

dorsal inter-ridge sclerite; three lower ridges joined anteriorly; distinct basal spur.

Opercula: Roughly sickle-shaped, obliquely elongated; somewhat domed and shiny centrally, with posterior region broadly undulate with slightly rugose surface; declivous flange along outer margin; colour dark brown on antero-medial region, becoming pale sandy-brown posteriorly and along outer margin.

Abdomen: Tergites 2 to 7 black with narrow reddish-brown zones developed adjacent to posterior margins, these zones not extending dorsally across each tergite; posterior margins of each tergite yellow-brown to orange; tergite 8 brown; short silver-gold pubescence most noticeable laterally and dorsolaterally. Sternites II to V orange-brown to brown, becoming reddish-brown towards sternites VI and VII; sternite VII marked by relatively large, black median area; sternites III to VI have smaller median, triangular black regions, anteriorly pointing, adjacent to posterior margin of each sternite; sternite II black medially; sternite VIII brown, darker anteriorly.

Genitalia: Pygophore black anteriorly, elsewhere brown; upper lobes form a pair of blinker-like structures, slightly twisted and decurved, with asymmetric terminations; claspers with anterior-pointing hooked processes; aedeagus with a pair of dorsal pseudoparameres, joined to endotheca near gonocoxite IX; pseudoparameres bifurcate distally, i.e. away from junction with endotheca, being sclerotised, tapering, acute, and with slight apical ornamentation.

FEMALE: Colouration and markings very similar to male, with some decrease in the proportion of black pigmentation. Head: Dorsal surface of head black with scattered brown markings. Thorax: Pronotum with pale brown and broader central fascia than in male, abruptly widening adjacent to pronotal collar. Mesonotum with black median fascia absent posteriorly, except for small black area adjacent to cruciform elevation. Legs: Pale to medium brown with longitudinal black fasciae only on coxae, and dark brown claws and spines. Abdomen: Black pigmentation on tergites reduced in area, the main colouration being reddish-brown, grading to orange laterally on tergites 2 and 3; tergite 9 medium brown with a pair of slightly curved black dorsolateral fasciae extending to near posterior edge of tergite. Sternites orange-brown with median triangular black areas, anteriorly pointing, along the posterior edge of each sternite, which become smaller from sternites V towards II; ovipositor sheath extends 3 to 4 mm beyond termination of tergite 9.

MEASUREMENTS: 13♂♂ and 13♀♀. Body length: ♂ 17.5-21.1 (19.15); ♀ 20.6-24.4 (22.63). Fore wing length: ♂ 21.1-24.4 (22.47); ♀ 22.6-26.4 (24.64). Head width: ♂ 5.6-6.4 (5.88); ♀ 5.7-6.8 (6.22). Pronotum width: ♂ 4.5-5.5 (4.90); ♀ 4.8-5.7 (5.18). Abdomen width: ♂ 4.7-5.5 (5.09); ♀ 4.6-5.4 (4.96).

COMMENTS

A second ?type, ♀, of *Melampsalta fletcheri*, of uncertain status, is held in ANIC. The location labels list the locality as 'Cooks R., NSW', and 'Sydney, 12.i.01, W.B.G.', ex MM and 'on permanent loan'. In the original description, a male specimen from the Museum of Victoria, Melbourne, is specifically cited, and this corresponds to the specimen in MV. The ANIC specimen, therefore, cannot be regarded as a type, although evidently a contemporary specimen.

This species is most closely allied to *P. rubea* and both partly overlap in habitats. Distinguishing features are given under the description of *P. rubea*.

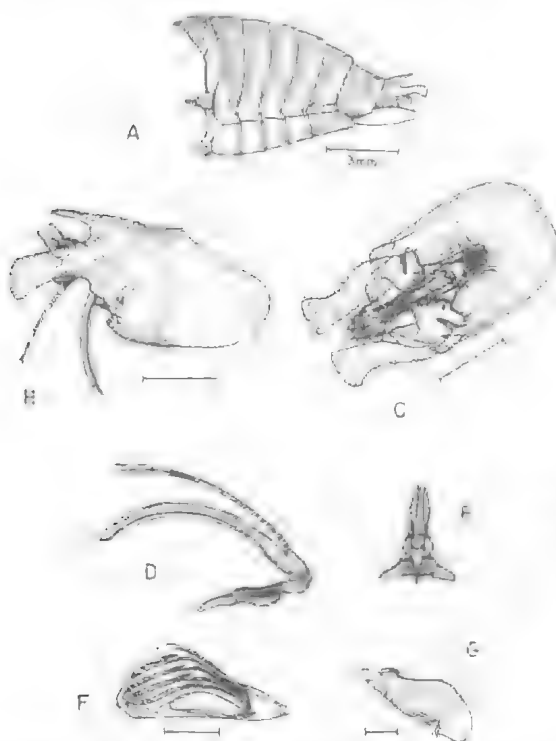


FIG. 33. *Pauropsalta marginata* (Leach) comb.n., ♂, based on specimens from Beerburum (north of Brisbane), and North Stradbroke Island. Symbols A to G, and scales, as in Fig. 2.

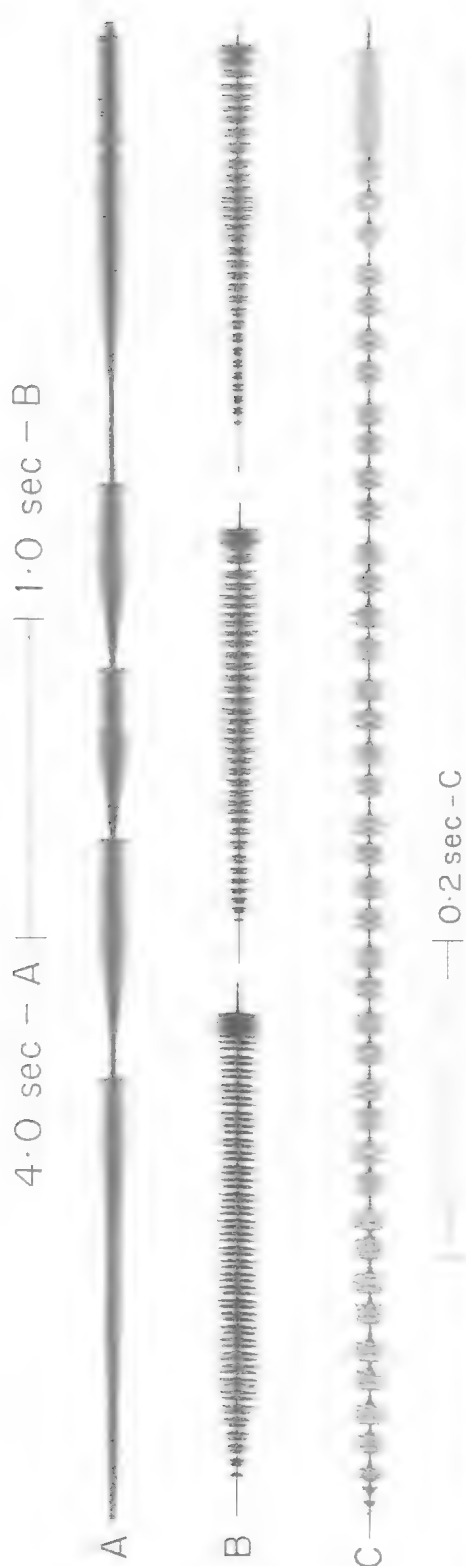


FIG. 34. Oscillograms of calling song of *P. marginata* from: A, Sutherland, Sydney (JM); B, southwestern Brisbane (first phrase) and North Stradbroke Island (second two phrases); C, further expanded time scale of southwestern Brisbane song phrase. Three time scales are shown.

DISTRIBUTION

Extends from Sydney, northwards through eastern New South Wales, southeastern Queensland to the Blackdown and Carnarvon tableland regions. It occurs in dry sclerophyll forest communities where the males normally sing from the higher trunks. Females, however, are frequently found near ground level ovipositing; plants on which oviposition has been observed include *Kunzia* sp., *Casuarina littoralis*, and *Eucalyptus trachyphloia*. It is active between October to April.

SONG

An irregularly repeated phrase, varying from 1.2 to 6.0 secs duration (Fig. 34). The interval between phrases varies from approximately 0.1 sec to many minutes. Each phrase initially has a progressive increase in amplitude which subsequently remains nearly constant. The final part of each phrase finishes with a short (70-85 msec) burst of increased pulse repetition frequency, giving the song its characteristic final tonal flourish, as heard by the ear. The expanded time scale (Fig. 34c) shows each phrase to consist of repeated double pulse groups, each showing a terminal damping, and each consisting of complex pulse triplets. The duration of each pulse group ranges between 12-16 msec, with an initial pulse of approximately 4-5 msec; intervals between the pulse group doublets is 8-14 msec; intervals between pulse groups forming each doublet is 4-6 msec. The final flourish of each phrase results from the merging of either two or three of the double pulse groups.

Pauropsalta vitellinus n.sp.

(Figs 8C,D,35,36,37,58)

Pauropsalta species E Ewart, 1988:182, figs 3,9E, Pl. 1D.

Pauropsalta sp. near *P. melanopygia* (Germar) St Leger Moss, 1988: 30.

MATERIAL EXAMINED

HOLOTYPE: ♂ QUEENSLAND, L. Broadwater, c. 30 km SW of Dalby, SEQ, 12.ii.1984, A. Ewart (QM, Reg. No. T.11151).

PARATYPES: QUEENSLAND: 1♂, 1♀, Burnett R., N of Eidsvold, 330 ft, 9.i.1970, at light, EB/GH/IM; 1♂, 1♀, L. Broadwater, c. 30 km SW of Dalby, 12.ii.1984, A.E.; (ANIC). 1♂, 1♀, L. Broadwater, c. 30 km SW of Dalby, 12.ii.1984, A.E. (BMNH). 1♂, 1♀, L. Broadwater, 30 km SW of Dalby, 12.ii.84, A.E. (MNDN). 1♀, L. Broadwater, c. 30 km SW of Dalby, 12.ii.1984, A.E. (QM). 2♂♂, 2♀♀, Burnett R., N Eidsvold, el. 100 m, 9.i.1970, J.T. Moss; 5♂♂, Cardwell, 6.ii.1981, J.T. Moss; 4♂♂, 1♀, Chinchilla, i.1984, G. Lithgow; 1♂, 2♀

mi. N of Gin Gin, 23.iii.1958, I.F.B. Common; 3♂♂, Percy Is., SE Mackay, 8-10.xi.1983, J.T. Moss; 6♂♂, 3♀♀, Waruma Dam nr Eidsvold, 25.xii.1984, J.T. Moss (JM). 1♀, Barcaldine, 10.ii.1981, M.S. and B.J. Moulds; 6♂♂, 3♀♀, Bungil Ck, 16 km N of Roma, 20.i.1987, M.S. and B.J. Moulds; 6♂♂, 3♀♀, Burnett R. crossing, N of Eidsvold, 28.i.1988, M.S. and B.J. Moulds; 1♂, Butcher Ck, 20 km W of Cloncurry, 21.i.1977, M.S. and B.J. Moulds; 6♂♂, 5♀♀, Campaspe R. crossing, WSW of Charters Towers, 17.i.1984, M.S. and B.J. Moulds, (eyes dark brown); 10♂♂, 7♀♀, Cape R., 100 km S of Charters Towers, 21.xii.1983, M.S. and B.J. Moulds; 1♀, Cloncurry, 19.i.1984, M.S. and B.J. Moulds; 2♂♂, 2♀♀, Edungalba, 5.xi.1979, M.S. and B.J. Moulds; 5♂♂, 7♀♀, Isaacs R. crossing, Dingo/Mt Flora road, 24.i.1982, M.S. and B.J. Moulds; 1♂, 1♀, L. Broadwater, c. 30 km SW of Dalby, 12.ii.1984, A.E., 1♀, L. Broadwater nr Dalby, site B, 27°21'S 151°06'E, 30.i.1987, G. and A. Daniels, mv lamp; 5♂♂, 3♀♀, L. Broadwater, via Dalby, 9.xi.1987, Montelth and Thompson; 10♂♂, 9♀♀, Miles, 20.i.1982, M.S. and B.J. Moulds; 1♀, 'Mourangee' nr Edungalba, xii.1983, E.E. Adams; 2♂♂, 3♀♀, 1 km W of Mourangee Hsd, nr Edungalba, on tree trunks, 17.xi.1984, E.E. Adams; 1♂, 3♀♀, 1 km SW of Mourangee Hsd, nr Edungalba, on grey box, 19.xii.1985, M. and S. Adams; 1♂, 3♀♀, nr Mourangee Hsd, nr Edungalba, 6-7.xi.1987, on gum trunks, M. and S. Adams; 15♂♂, 8♀♀, creek at Mourangee Hsd, nr Edungalba, 20.xii.1987, M.S. and B.J. Moulds; 6♀♀, 9♀♀, Springsure, 15.xii.1979, P.S. Valentine; 2♂♂, 2♀♀, Torrens Ck township, 90 km E of Hughenden, 3.ii.1981, M.S. and B.J. Moulds, (Black eyes) (MSM). 1♂, 'Rockwood', nr Chinchilla, 4.ii.1983, C. Cameron; 24♂♂, 27♀♀, L. Broadwater, c. 30 km SW of Dalby, 12.ii.1984, A.E. (AE).

ETYMOLOGY

Derived from Latin *vitellinus*, meaning yellow (as in yolk of an egg), which refers to general colouration of the cicada.

DESCRIPTION

MALE: *Head:* Postclypeus shiny black anteriorly with a broad sandy-brown spot dorsally on midline; sparse silver-gold pubescence; dorsal surface black with yellow pubescence. Anteclypeus black with silver-yellow pubescence. Rostrum pale brown, becoming deep brown apically, extends to mid coxae. Gena and mandibular plate black with pallid intervening suture; prominent silver-yellow pubescence. Antennae medium to dark brown. Ocelli pale reddish-brown. Eyes medium brown. Dorsal surface of head black with pallid triangular area in suture between ocelli, anteriorly pointing, and extending from posterior margin of head; silver-yellow pubescence, especially prominent behind eyes. Vertex lobes pale brown.

Thorax: Pronotum with a pair of deep brown to black, somewhat rounded patches occurring

dorsolaterally to laterally i.e. around oblique fissures; remaining areas sandy-brown, except for small black, discontinuous zones adjacent to central fascia; central fascia pale sandy-brown; pronotal collar pale reddish-brown; anterior margin sandy-brown; short yellowish pubescence, mainly concentrated dorsolaterally and laterally.

Mesonotum: Broad black lateral fasciae extending from cruciform elevation, and which widen anteriorly; median fascia coalescing with dorsolateral fasciae, forming black, obconical anterior area on mesonotum, extending to beneath pronotal collar; posterior part of median fascia somewhat diffuse, merging with a pair of black dorsolateral spots immediately adjacent to cruciform elevation; remaining areas pale sandy-brown, including cruciform elevation; yellowish pubescence most conspicuous around cruciform elevation and along wing grooves and adjacent ridges.

Legs: Pale orange-brown with dark brown tips to spines and claws.

Wings: Fore wings with pale brown venation becoming progressively darker distally around apical cells and ambient vein; pterostigma pale brown; very faint narrow, brown infuscation along vein CuA₂ close to join with vein 1A+2A; infuscation spots on anal margins of hind wings are small.

Tymbals: Dorsal tymbal ridge extends across dorsal inter-ridge sclerite; the lower two, or in some specimens three ridges joined anteriorly; distinct basal spur.

Opercula: Roughly sickle-shaped, obliquely elongated; central region shiny, sandy-brown to yellow-brown, and somewhat domed; finely rugose surface; declivous narrow flange along outer margin; inward facing termination rounded; more or less longitudinally undulate (i.e. parallel to body axis).

Abdomen: Tergite 2 with conspicuous black anterior zone of pigmentation extending from dorsally to lower edge; posterior region of tergite 2 orange-brown; tergites 3 to 7 orange to yellow-brown, more deeply coloured along posterior margins, and with short, centrally placed, dorsal black bands which extend dorsolaterally in tergite 7; the extent of these black bands are, however, variable between individual specimens, and in some are completely absent (even in the one locality); tergite 8 is conspicuously black with narrow, irregular reddish-brown posterior margin, and very narrow, discontinuous, orange-brown anterior margin. Sternite II black medially, otherwise sternites II to VI orange, orange-brown

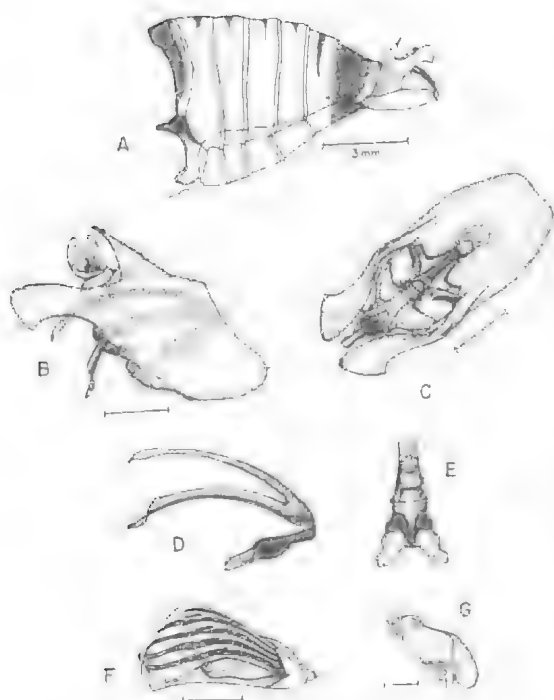


FIG. 35. *Pauropsalta vitellinus* sp.n., ♂, from Lake Broadwater, near Dalby, southern Queensland. Symbols A to G, and scales, as in Fig. 2.

to yellow; sternite VII orange anteriorly, black posteriorly; sternite VIII with anterior black patches of pigmentation, otherwise orange-brown to brown.

Genitalia: Pygophore medium brown with dark brown to black pigmentation developed anteriorly; upper pygophore lobes sub-ascending, slightly curved, blinker-like structures, with shallow hooked and flattened termination; claspers with anterior-pointing hooked processes; aedeagus with a pair of dorsal pseudoparameres which bifurcate distally; pseudoparameres join endotheca near to join with gonocoxite IX, and are tapering, acute, and outward pointing apically; apical terminations of endotheca produced into a conspicuous collar-like structure, slightly ornamented.

FEMALE: Colouration and markings as described for male, but with less black pigmentation on head and thorax, but more persistent and extensive black pigmentation on tergites. Head: Postclypeus as in male, but more brown colouration, extending as narrow median fascia on to dorsal surface; gena predominantly

pale brown; dorsal surface of head black with irregular brown anterior and lateral patches. Thorax: Pronotum sandy-brown with only irregular and broken black pigmentation around oblique fissures; mesonotum, legs, and wings as in male. Abdomen: Tergites 2 to 8 reddish-brown each with dorsal to dorsolateral, irregular anterior areas of black pigmentation, concentrated dorsally to dorsolaterally; posterior margins of tergites yellow to yellow-brown; abundant short yellow pubescence; tergite 9 brown with a pair of slightly curved dorsolateral black fasciae extending to near posterior edge of tergite. Sternites II to V orange to yellow-brown, becoming brown on sternites VI and VII. Ovipositor sheath dark brown to black apically, and extending 1-2 mm beyond tergite 9.

MEASUREMENTS: 29♂♂ and 32♀♀. Body length: ♂ 17.3-21.3 (18.98); ♀ 19.8-23.4 (21.06). Fore wing length: ♂ 20.8-23.9 (22.81); ♀ 23.4-25.9 (24.33). Head width: ♂ 5.3-6.2 (5.90); ♀ 5.9-6.7 (6.22). Pronotum width: ♂ 4.6-5.4 (4.96); ♀ 5.1-5.6 (5.29). Abdomen width: ♂ 4.6-5.5 (5.16); ♀ 5.0-5.5 (5.13).

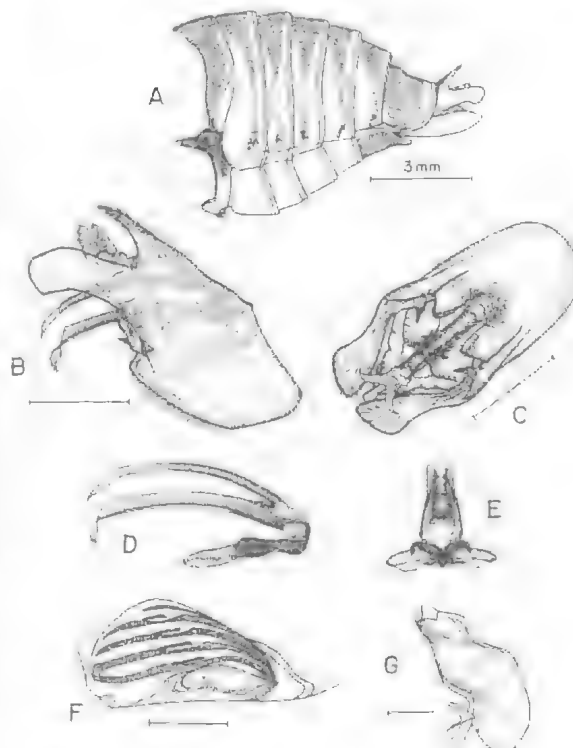


FIG. 36. *Pauropsalta vitellinus* sp.n., ♂, from Cardwell, northern Queensland (JM collection). Symbols A to G, and scales, as in Fig. 2.

COMMENTS

This species is most similar to *P. virgulatus*. The males are distinguished by song (Figs 37,39); length of dorsal tymbal ridge (short, not extending beyond dorsal inter-ridge sclerite in *P. virgulatus*; longer, extending across dorsal inter-ridge sclerite in *P. vitellinus*); and opercula colouration (sandy-brown to yellow-brown in *P. vitellinus*; extensive black to dark brown anterior pigmentation in *P. virgulatus*). The females are distinguished on the basis of ovipositor sheath lengths (extending 1.2 mm beyond tergite 9 in *P. vitellinus*; less than 0.5 mm in *P. virgulatus*). The females may also sometimes resemble *P. marginata*, but ovipositor sheath lengths are a useful distinguishing feature (extending 3.4 mm beyond tergite 9 in *P. marginata*). *P. nigristriga* may also be confused with *P. vitellinus*. The males, however, are readily distinguished by the shapes of their respective upper pygophore lobes (exaggerated 'hook like' form in *P. nigristriga*), while again the relative ovipositor sheath lengths distinguish the females (longer in *P. nigristriga*, extending 2.5-3 mm beyond tergite 9).

DISTRIBUTION

Specimen and aural records indicate a wide distribution through southern central Queensland, northwards to Cardwell and coastal region adjacent to the Paluma Range, and extending westwards to Cloncurry (Fig. 58). This cicada is usually found high up in trees in dry open mixed forest, often bordering swamps and open grassland. Near Cardwell, it occurs on coastal melaleucas and *Eucalyptus alba*, at low to middle heights on trunks. This cicada is locally abundant and records range from November to February.

SONG

This consists of a series of relatively short, sharp, compound phrase groups (here simply referred to as phrases), which are continuously, rapidly, and regularly repeated (Fig. 37). In the field, these phrases tend to be emitted in unison amongst groups of individuals.

Two separate recordings are shown, one from Lake Broadwater (near Dalby), the second (JM) from the coast adjacent to the Paluma Range, northern Queensland. Although, the basic song

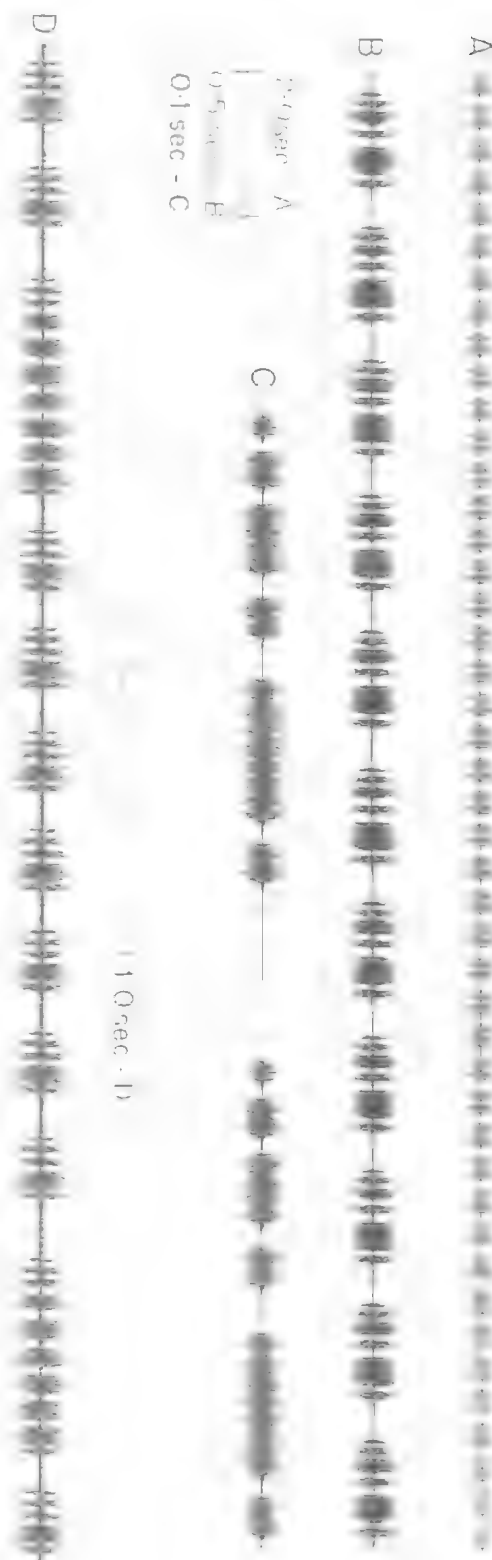


FIG. 37. Oscillograms of calling songs of *P. vitellinus* from: A to C, Lake Broadwater (Feb. 1984); D, coast adjacent to Paluma Range, northern Queensland (JM). Three time scales are shown; note that records B and D have the same scale.

structures are similar, notable differences do occur. The oscillograms show that each phrase consists of a series of discrete subphrases (these strictly representing compound pulse groups); these number from six (Lake Broadwater) to either five or between nine to eleven (Paluma Range), the latter constituting what are here called 'short' (= normal) or 'long' phrases, respectively. An increase in amplitude occurs during the first two or three subphrases, thereafter remaining constant.

Table 3 details the timing of the phrases and subphrases for the two sets of recordings:

Lake Broadwater Song: Examination of the phrases on an expanded time scale (Fig. 37c) suggest a basic compound pulse unit with an average duration of 12.5 msec; each of these units show, within them, a tendency for increasing amplitudes midway through their emission which results in a rough modulation (with frequency of 80 Hz) to each subphrase. Each pulse group unit itself contains at least 10 to 11 separate 'pulses' (each in fact a finer scaled pulse subgroup, not resolvable with the available data); the pulse repetition frequency is estimated to be approximately 890 Hz.

It is evident that the subphrases are made up of multiples, formed by coalescence, of the basic compound pulse units i.e. subphrases 1 to 6 consist of groups of 1, 2, 4, 2, 8, and 2 pulse group units, respectively. The fact that exact numerical correspondences do not occur is evidently due to damping and presumably also resonance effects.

Paluma Range Coast Song: Although this has the same basic structure of the Lake Broadwater song, clear differences are apparent. These consist of the number of subphrases, the occurrence of 'short' and interspersed 'long' phrases, and some subphrase timing differences (although some are closely similar, as shown in Table 3). The 'long' phrases are the result of the repetition of the fourth subphrase in the normal 'short' song (by up to seven times). The final interval and subphrases of the 'short' and 'long' phrases are closely similar. Although the resolution of the Paluma recording is not sufficient to clearly establish the finer pulse structure of the songs, expanded time scale oscillograms (not shown) do suggest very similar compound pulse units to those found in the Lake Broadwater song.

Thus, as with some of the other *Pauiropsalta* species songs, there is geographic variation in song patterns. Clearly, experiments are needed to see whether the Paluma insects recognise the Lake Broadwater call, and *vice versa*.

TABLE 3. Comparative data on calling song patterns of *P. vitellinus*.

	Paluma Range Coast		L. Broadwater
	Short Phrase	Long Phrase	
Length of phrase (sec)	0.21-0.22	0.55-0.76	0.33-0.34
Duration interval between adjacent phrases (sec)	0.12-0.18		0.12-0.14
Details of subphrases and intervening intervals (mean values, msec):			
1st subphrase	15.3	14.0	16.2
1st interval	(16.0)	(16.6)	(9.2)
2nd subphrase	24.8	25.2	28.2
2nd interval	(18.9)	(17.6)	(10.2)
3rd subphrase	25.1	24.6	50.6
3rd interval	(19.2)	(30.0)	(15.6)
4th subphrase	63.4	51.6	29.4
4th interval	(9.0)	(35.2)	(29.1)
5th subphrase	24.0	63.0	99.7
5th interval	—	(33.0)	(17.4)
6th subphrase	—	64.4	29.3
6th interval	—	(29.0)	—
7th to 10th subphrases*	—	62.6-64.0	—
7th to 9th intervals*	—	(21.0-24.0)	—
First interval*	—	(8.6)	—
Final subphrase*	—	24.2	—

*long phrase only

***Pauiropsalta virgulatus* n.sp.**
(Figs 38,39,52A,B,58)

MATERIAL EXAMINED

HOLOTYPE: ♂ QUEENSLAND, Atherton Tableland, nr Mareeba, NQ, Nov-Dec 1982, J.T. Moss (QM, Reg. No. T.11149).

PARATYPES: QUEENSLAND: 4♂♂, Herberton, 26.xii.1949, G.B.; 2♂♂, Herberton, 28.ii.1950, J.C. Brooks; 4♂♂, Herberton, 28.xii.1950, G.B.; 3♂♂, Herberton, 11-17.i.1954, G.B.; 1♀, Herberton, 11-17.i.1954, G. Brooks; 2♂♂, Kuranda, 5.iii.1950, GB; 1♂, 1♀, Kuranda, 28.i.1951, G.B.; 1♂, Kuranda, 3.i.1953, GB; 2♂♂, Mareeba, 2.i.1953, GB. (MV). 1♀, Station Ck, nr Mt Carbine, 4.iii.1981, J.T. Moss (QM). 2♂♂, Blackdown Tableland, Expedition Range, 5-6.xii.1979, M.A. Schneider, G. Daniels, mv lamp; 1♂, Mareeba, 3.i.1941, P.(U.)O'S (UQIC). 2♂♂, as for holotype; 2♂♂, Clohesy R., Atherton Tableland, 20.iv.1985, J.T. Moss; 3♂♂, 1♀, Fraser Is., i.1978, A. Moss; 4♂♂, 4♀♀, L. Elphinstone, nr Glenden, 20-29.ii.1984, J.T. Moss; 1♂,

Longmans Gap, 12.i.1962, Carne and Britton; 3♂♂, *E. grandis* forest, NW of Paluma, 27-30.i.1981, J.T. Moss; 11♂, 1♀, Station Ck, nr Mt Carbine, 4.iii.1981, J.T. Moss (JM). 1♀, Baldy Mt, Atherton, 15.i.1979, A. and M. Walford-Huggins; 1♂, Davies Ck, Lamb Range, Mareeba Dist., i.1985, S. Lamond; 2♂♂, Expedition Range, Blackdown Tablelands, 1-6.ii.1981, G.B. Monteith; 1♂, Forty Mile Scrub, 65 km SW of Mt Garnet, 10.xi.1981, A. Walford-Huggins; 5♂♂, 2♀♀, Gordonvale, 2.i.1986, S. Lamond; 3♂♂, nr Herberton, 13.i.1977, M.S. and B.J. Moulds; 1♂, 7 km S Herberton, 18.i.1979, R.I. Storey, at light; 1♀, Irvinebank, W of Herberton, 9.i.1983, G. Wood; 2♂♂, Lock Ck, Davies Ck Rd, Lamb Range, Mareeba Dist., 25.xii.1976, M.S. and B.J. Moulds; 2♂♂, 1♀, Lustre Ck between Mt Molloy and Mt Carbine, 20.ii.1975, G. R. Brown; 5♂♂, 1♀, Mareeba, i.1986, S. Lamond; 5♂♂, 4♀♀, nr Mt Fox, SW of Ingham. Edge of rainforest and *Euc. grandis*, 550 m, 3.ii.1986, J. Young, 6♂♂, 4♀♀, 14.ii.1986, 3♂♂, 3♀♀, 15.ii.1986, 5♂♂, 3♀♀, 16.ii.1986, 1♂, 26.xi.1986, 4♂♂, 3♀♀, 4.xii.1986, 4♂♂, 1♀, 6.xii.1986, 9♂♂, 6♀♀, 23.xii.1986; 1♂, 1♀, 36 mi SW of Mt Garnet, 22.i.1977, B.P. Moore; 1♂, 4♀♀, Mt Lewis nr Julatten, i.1986, S. Lamond; 1♂, 5.2 m. W Paluma, 3000', 13.xii.1972, J.G. Brooks; 1♂, 2♀♀, Ravenshoe, i.1986, S. Lamond; 2♂♂, Running R., W of Paluma, 6.i.1986, E.E. and E.W. Adams; 1♂, 2♀♀, Running R. area, 8.5 km W of Paluma, flood gum country, 7.i.1986, E.E. and E.W. Adams; 2♂♂, 20 mi. along Tinaroo Ck Rd nr Mareeba, at M.V.L., 30.xii.1972, M.S. and B.J. Moulds; 1♀, Tinaroo Ck Rd nr Mareeba, 21.i.1982, G. and A. Daniels, rainforest edge; 1♂, 1♀, Tinaroo Dam, nr Atherton, 22.xii.1981, J. Olive; 1♂, Tinaroo Dam wall nr Atherton, 22.ii.1982, M.S. and B.J. Moulds; 5♂♂, 2♀♀, Tinaroo Lakes, 22.xii.1981, J. Olive (MSM). 1♀, Gordonvale, 2.i.1986, S. Lamond; 2♂♂, nr Mt Fox, SW of Ingham, Edge of rainforest and *Euc. grandis*, 550 m, 3.ii.1986, J. Young, 1♀, 14.ii.1986, 1♀, 15.ii.1986, 1♂, 16.ii.1986; 1♂, Ravenshoe, i.1986, S. Lamond; 1♀, Mareeba, i.1986, S. Lamond (AE).

ETYMOLOGY

Derived from *Latin virgulatus*, meaning striped.

DESCRIPTION

MALE: Head: Predominantly black. Postclypeus shiny black anteriorly with pale sandy-brown margin and elliptical pale spot dorsally on midline; dorsal surface black; short silver yellow pubescence. Anteclypeus shiny black with silver-yellow pubescence. Rostrum medium brown, becoming darker apically, and extending to mid coxae. Gena and mandibular plate black with pale brown intervening ridge (enlarged adjacent to postclypeus) and marginal ridges; conspicuous silvery-yellow pubescence. Antennae deep brown. Vertex lobes dark reddish-brown. Ocelli pink. Eyes dark brown. Dorsal surface of head black with pallid triangular depressed area located

posteriorly on longitudinal suture between ocelli; yellow-brown pubescence especially conspicuous behind eyes.

Thorax: Pronotum black with a conspicuous pale sandy-brown central fascia, not quite extending to pronotal collar; pronotal collar and anterior margin pale brown; short yellowish pubescence.

Mesonotum dominantly black with a pair of narrow, somewhat indistinct, curved dorsolateral medium brown bands extending longitudinally to anterior arms of cruciform elevation; wing grooves pale brown; cruciform elevation pale brown, black between arms; sparse yellowish pubescence, most conspicuous around cruciform elevation.

Legs: Coxae dominantly black to deep brown, but tending paler along posterior margins; femora dark brown anteriorly, pale brown along posterior margins, the hind femora being generally paler; tibiae and tarsi pale sandy brown; claws and spines dark brown.

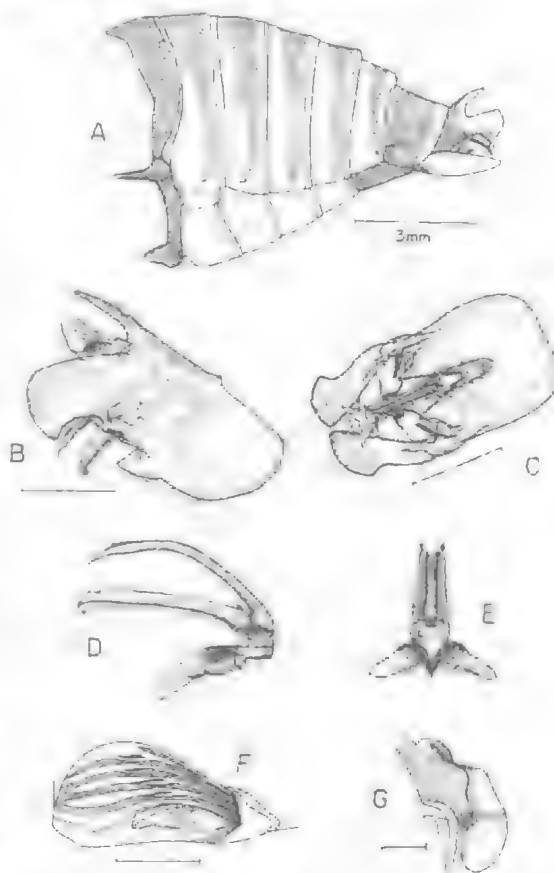


FIG. 38. *Pauropsalta virgulatus* sp.n., ♂, from Atherton Tableland, near Mareeba, northern Queensland (JM collection). Symbols A to G, and scales, as in Fig. 2.

Wings: Costal veins of fore wing pale brown, remaining venation dark brown, becoming darker along ambient vein; infuscation along vein 1A + 2A on fore wings faint; infuscation spots on hind wings distinct.

Tymbals: Dorsal ridge short, not extending across dorsal inter-ridge sclerite; lower three ridges normally joined anteriorly.

Opercula: Broadly sickle-shaped, longitudinally undulate (i.e. parallel to body axis), with asymmetrically rounded inward (posterior) termination; no clear domed structure; anteriorly black to dark brown, becoming pale sandy-brown around posterior margin; declivous marginal flange most noticeable along outer margin; surface finely rugose.

Abdomen: Tergite 2 black with narrow brown and yellow-brown zone adjacent to posterior margin; tergites 3 to 7 yellow-brown to orange-brown with well defined black bands running around each tergite, each band broadest dorsally and narrowing and terminating towards lower edge; tergite 8 mostly black with narrow anterior and posterior pale brown margins; posterior margins to tergites orange-brown. Sternite II black; sternites III to VI orange-brown; sternite VII mostly black; sternite VIII pale brown with small anterior median black area.

Genitalia: Pygophore black anteriorly, otherwise pale brown; upper lobes form broad blinker-like structures with broadly curved and hooked terminations; inner lobes raised and acutely tapering; claspers with hooked terminations; dorsal pseudoparameres approximately same length as endotheca, and bifurcate distally; endotheca slightly curved with pointed, tripartite and hooked terminations.

FEMALE: Markings and colouration similar to male, with reduction in extent of black pigmentation on mesonotum and abdomen. Pronotum: Pale brown triangular area extending from posterior edge of central fascia along dorsolateral edge of pronotal collar. Mesonotum with broader, irregular pale brown dorsolateral fasciae, and additional pale brown lateral oblique fasciae, the two pairs of fasciae coalescing adjacent to anterior arms of the cruciform elevation; the dorsolateral fasciae also broaden laterally, resulting in a distinct black area anteriorly to cruciform elevation. Abdomen: Tergites 2 to 7 with distinct dorsal black bands, which terminate dorsolaterally; on tergite 8, the black band extends from dorsally to lower edge; tergite 9 with a pair of dorsolateral longitudinal black fasciae which coalesce near posterior margin

of tergite; remaining colouration of all tergites pale brown to orange-brown with posterior margins yellow brown. Sternites orange to orange-brown; ovipositor sheath extends only just beyond (< 0.5 mm) tergite 9.

MEASUREMENTS: 40♂♂ and 8♀♀. Body length: ♂ 14.0-18.8 (16.77); ♀ 16.0-18.3 (17.65). Fore wing length: ♂ 17.0-22.4 (20.71); ♀ 20.3-22.4 (21.25). Head width: ♂ 4.7-5.8 (5.29); ♀ 5.1-5.6 (5.41). Pronotum width: ♂ 4.0-4.8 (4.35); ♀ 4.3-4.6 (4.40). Abdomen width: ♂ 4.0-5.1 (4.72); ♀ 4.3-4.8 (4.55).

COMMENTS

As noted in the description of *P. vitellinus*, these two species are similar, and reference should be made to the latter species for distinguishing features.

DISTRIBUTION

Most records are from the Atherton Tableland region south to near Mt Garnet and north to near Mt Carbine (Fig. 58). Southerly records extend through the Paluma Range, the Blackdown Tableland, and near Glenden, to as far south as Fraser Island. Preferred habitat is open dry forest where the cicada tends to occur relatively low down. It is recorded from November to April.

SONG

Two sets of recordings are available (JM) — one from near Mt Carbine and a second from the Paluma Range (Fig. 39). As with previous songs, these two songs also exhibit differences although showing the same basic song patterns.

The song consists of a regularly repeated compound phrase group, comprising a set of initial short subphrases, followed by a longer subphrase, this showing increasing (although somewhat variable) amplitude towards the end of the subphrase. A major difference between the songs is the number of short subphrases emitted, varying from two pairs of two (Mt Carbine) to four, or less often five, pairs of two (Paluma Range); the interval between the emission of successive pairs tends to decrease during the emission of each phrase group. Table 4 summarise timing details measured for the two song patterns.

Expanded time scale oscillograms do not give clear high resolution information for either song pattern, but are sufficient to indicate that the phrases comprise compound pulse groups, of 4-6 msec duration, which coalesce into clusters of two, three, or four sets of pulse groups.

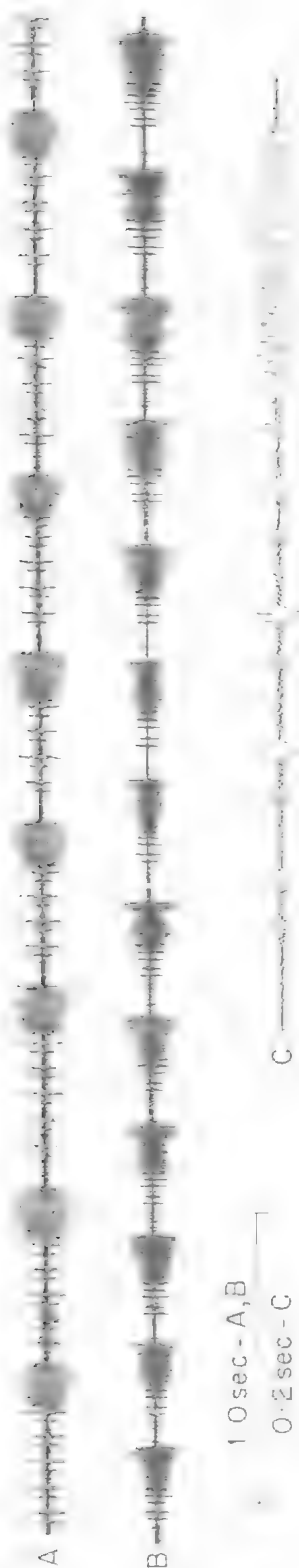


FIG. 39. Oscillograms of calling songs of *P. virgatus* from: A, C, Paluma Range, northern Queensland (JM); B, Mt Carbine, northern Queensland (JM). Two time scales are used, with A and B having the same scale.

TABLE 4. Comparative data on calling song patterns of *P. virgatus*.

	Mt Carbine	Paluma Range
Duration of short subphrases (msec)	6-8 (less often 16)	8-10 (first pair) 12-14 (second pair)
Duration of long subphrases (sec)	0.16-0.22	0.16-0.18
Intervals between short subphrases (msec)		
(a) between subphrases of same pair	10-15	17-20
(b) between adjacent pairs	25-35	32-48
Intervals between phrase group (sec)	0.10-0.15	0.10-0.14

***Pauropsalta nigristriga* Goding and Froggatt**
(Figs 8E,F,40,41,58)

Pauropsalta nigristriga Goding and Froggatt, 1904:619,620; Distant, 1906b:179; Moulds, 1987:17,18, figs 1,3,4.

MATERIAL EXAMINED

HOLOTYPE: ♂ of *Pauropsalta nigristriga*, in ANIC: Endeavour R., also bearing red type label, ex MM, and 'on permanent loan' to ANIC.

OTHER MATERIAL: 21♂♂, 9♀♀ from following localities. QUEENSLAND: Hambledon; Kuranda; Mareeba, Mowbray R. (MV). Ellis Beach; 15,10S 145.07E, 3.5 km SW by S of Mt Baird, nr Cooktown; Station Ck, nr Mt Carbine (JM). Annan R. crossing, Grass Tree Pocket Road; Cairns; Clohesy R. crossing, Mareeba-Kuranda Road; Davies Ck crossing, Mareeba Road; 15 mi. along Gunawarra Rd, via Mt Garnet; Laura R., at old homestead; Mt Molloy; 10 km S of Mt Molloy; 10 km S of Woodstock, S of Townsville; York Downs, 50 km E of Weipa (MSM).

DESCRIPTION

MALE: Head: Postclypeus shiny black anteriorly with broad pale sandy-brown margin, extending between transverse ridges; conspicuous pallid area dorsally on midline; dorsal surface with median thin pallid fascia extending from midline to median ocellus; fine silvery pubescence especially along transverse ridge. Anteclypeus shiny black with conspicuous silvery pubescence. Rostrum pale brown becoming darker apically; just extends to hind coxae. Gena and mandibular plate black with intervening and marginal ridges pallid; conspicuous silver pubescence. Antennae medium brown. Vertex lobes pale sandy brown. Ocelli pink. Eyes dark brown. Dorsal surface of head with pallid triangular area situated on longitudinal

suture between ocelli, and small dorsolateral posterior pallid area adjacent to eyes; silvery pubescence conspicuous behind eyes.

Thorax: Pronotum black with pale sandy-brown anterior margin, pronotal collar, broad central fascia, and median to dorsolateral area extending from posterior end of central fascia to pronotal collar; short silvery pubescence.

Mesonotum black with dorsolateral pale sandy-brown fasciae, widening medially, and a pair of pale sandy-brown oblique, broad, lateral fasciae; both sets of fasciae coalesce near anterior arms of cruciform elevation; cruciform elevation pallid, black anteriorly; wing grooves and adjacent ridges pallid; silvery pubescence especially along wing grooves and around cruciform elevation.

Legs: Coxae deep brown to black with pale sandy-brown outer margins; fore femora dark

brown anteriorly, with alternating pale and medium brown areas; mid and hind femora with alternating dark and pale brown longitudinal fasciae, tending darker anteriorly; fore tibiae medium brown; mid and hind tibiae pale sandy-brown; tarsi pale brown; claws and spines dark brown.

Wings: Venation dark brown, except pale brown costal veins of fore wings; infuscation spots on hind wings weak.

Tymbals: Dorsal ridge does not fully extend across dorsal inter-ridge sclerite; lower two ridges joined anteriorly; distinct basal spur.

Opercula: Broadly sickle-shaped, undulate, with anterior domed region; broad, rounded inward (posterior) termination; marginal declivous flange, best developed along outer margin; colour dominantly very pale sandy-brown, except for relatively small deep brown anterior area; surface finely rugose.

Abdomen: Tergite 2 black antero-dorsally, and laterally, otherwise orange-brown; tergite 3 to 7 orange-brown, with black dorsal to dorsolateral bands; tergite 8 dominantly black except for irregular orange-brown posterior margin; posterior margins of tergites orange-brown. Sternite II mostly black with smaller pale brown lateral margins; sternites III to VI, and intervening posterior margins of sternites orange-brown; sternite VII mostly black with antero-lateral pale brown area, in some specimens also paler along posterior margin; sternite VIII pale to medium brown, darker anteriorly.

Genitalia: Pygophore dark brown to black anteriorly, otherwise pale sandy-brown; upper lobes well developed into ascending and strongly curved 'hook-like' form (as seen laterally); inner and lower lobes distinct; claspers hooked; a pair of dorsal curved pseudoparameres, longer than endotheca, which bifurcate and join endotheca near gonocoxite IX.

FEMALE: Colouration and markings similar to male, with some decrease in extent of black pigmentation. Dorsal surface of postclypeus has broad median pallid area, and pallid patches on dorsal surface of head enlarged. Fore and mid legs are more extremely coloured with medium and pale brown longitudinal fasciae. Tergites and posterior margins of tergites are dominantly orange-brown to pale brown, with broken brown patches on tergite 2; the dorsal darker areas on tergite 3 to 7 are medium to dark brown, and less clearly defined than in male; tergite 8 pale sandy brown, with dark brown narrow anterior margin dorsally and dorsolaterally; tergite 9 pale brown

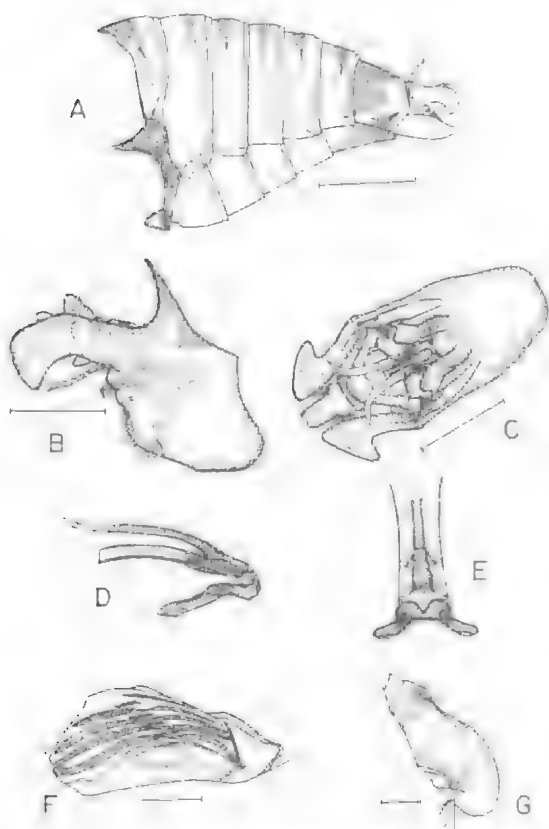


FIG. 40. *Pauropsalta nigristriga* Goding and Froggatt, ♀, from Station Ck, near Mt Carbine, northern Queensland (JM collection). Symbols A to G, and scales, as in Fig. 2.

with pair of darker longitudinal, dorsolateral broad fasciae, broadened anteriorly, but not reaching posterior margin; an additional pair of dark brown postero-lateral spots. Sternites pale brown to orange-brown with pale brown, median, triangular-shaped areas on sternites III to VII; ovipositor sheath extends 2.5-3 mm beyond tergite 9.

MEASUREMENTS: 21 ♂ and 8 ♀. Body length: ♂ 17.0-20.6 (19.14); ♀ 20.5-23.9 (22.17). Fore wing length: ♂ 22.0-24.9 (23.68); ♀ 22.0-25.4 (23.88). Head width: ♂ 5.1-5.8 (5.52); ♀ 5.3-5.8 (5.60). Pronotum width: ♂ 5.0-5.5 (5.21); ♀ 5.0-5.4 (5.27). Abdomen width: ♂ 5.6-6.4 (6.00); ♀ 5.3-5.8 (5.59).

COMMENTS

This species was synonymized by Ashton (1914:355) with *P. melanopygia* (Germar). This action was followed by subsequent workers until Moulds (1987) removed it from synonymy. This species is similar to *P. infrasila* and *P. opacus*; the main distinguishing features of *P. nigristriga* are the strongly angulated (or 'hooked') upper pygophore lobes (male) and the relatively long female ovipositor sheath extending 2.5-3.0 mm beyond tergite 9. The same features enable *P. vitellinus* and *P. virulatus* (with less angulated pygophore lobes and shorter ovipositors) to be easily distinguished from *P. nigristriga*.

DISTRIBUTION

Restricted to northeastern Queensland, mainly along the eastern side of the dividing ranges, from near Laura southwards to Woodstock, south of Townsville (Fig. 58). A single record exists from York Downs, near Weipa. Habitat preference is for open forest. The cicada occurs between December to March.

SONG

Based on a recording from near Mt Carbine (JM), the song consists of regularly repeated phrases, each showing an initial amplitude rise, thereafter remaining roughly constant, although there is a weak indication of some modulation; each phrase ends abruptly (Fig. 41). Phrase lengths vary between 1.2-1.4 secs, the corresponding inter-phrase intervals being 0.22-0.31 sec.

The pulse structure constituting the phrases has a bimodal amplitude distribution, with regularly alternating high and low amplitude pulses, the latter being asymmetric, possibly resulting from the coalescence of three smaller pulses, each with progressively increasing amplitude. The pulse repetition frequency of each of the high and low amplitude pulses is estimated to be 115-120 Hz.

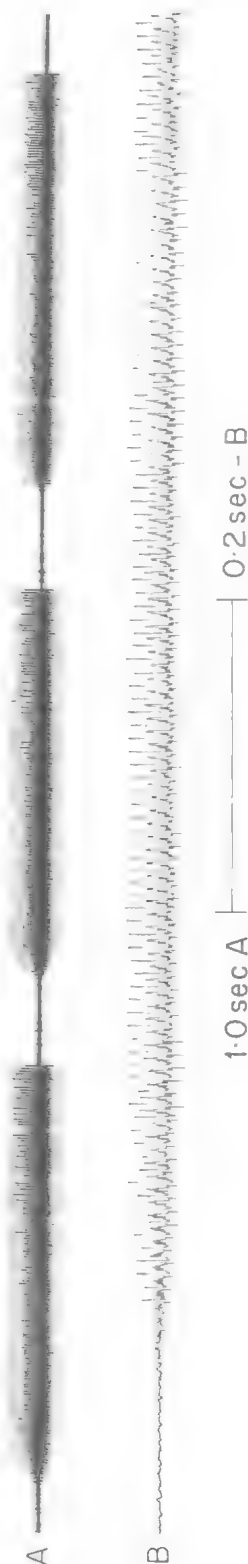


FIG. 41. Oscillograms of calling song of *P. nigristriga* from near Mt Carbine (JM). The song is shown on two time scales.

P. ANNULATA SPECIES-GROUP

Four species are recognised in this group but only three are described here. The fourth, *P. rubristrigata* (Goding and Froggatt), occurs from the Australian Capital Territory through to South Australia (Moulds, in press). These are small to medium sized cicadas (11–25 mm body length) with the usual preference for open forest habitats, and in Queensland, most commonly occurring in outer foliage, although *P. ayrensis* also occurs in shrubs and grass. The Queensland species are most common along the coastal region east of the Dividing Range, but *P. eyrei* extends into northwestern Queensland; *P. annulata*, although a southeastern Queensland insect, also has some apparently isolated inland populations, notably within the Blackdown and Carnarvon Tablelands. Both *P. annulata* and *P. ayrensis* — being relatively small, blackish species — have previously been loosely grouped under the name *P. encastica* (e.g. Burns, 1957; Moulds, in press), as with many of the smaller cicadas within the *P. marginata* group.

***Pauropsalta annulata* Goding and Froggatt**
(Figs 42, 43, 44, 45A, B, 59)

Pauropsalta annulata Goding and Froggatt.
1904:620, 621; Metcalf, 1963:405; Ewart, 1986:51;
Ewart, 1988:181, fig. 9A, Pl. 4C.

MATERIAL EXAMINED

LECTOTYPE: ♂ of *Pauropsalta annulata* here designated, in ANIC: Southport, Queensland, 16.x.1901, W.W. Froggatt; ex MM and 'on permanent loan' to ANIC.

OTHER MATERIAL: 350 specimens from following localities. QUEENSLAND: Comet; Millmerran (ANIC); Birkdale, Brisbane; Brisbane; National Park; Ormiston (QM); Brisbane, Coolum (MV). Blackdown Tableland; Brookfield, Brisbane; Caloundra; Cania Gorge, 26 km NW of Monto; Carnarvon Gorge; Goomeri; Gympie; Hervey Bay; 24 mi. SW by W of Kingaroy; Nambour; Pt Vernon, Hervey Bay; Rochedale, Brisbane; Urangan, Hervey Bay; Wallaville; Waruma Dam, nr Eidsvold; Yaamba, N of Rockhampton (JM). Armstrong Ck, Dayboro; Burnett R. crossing, N of Eidsvold; 28 km W of Condamine; 40 km WNW Goondiwindi; Kimbombi Falls, Goomeri; 116 km S of Mitchell; Mt Moon, nr Boonah; Toowoomba, scrub below escarpment; Wilheott, c. 8 km NE Toowoomba (MSM). Blackdown Tableland; Burnett Ck, nr Mt Maroon; Carnarvon Gorge; Charlevue Ck causeway, c. 10 km from Horseshoe Lkt., base of Blackdown Tableland; Chelmer, Indooroopilly and St Lucia, Brisbane; Crows Nest; Doolandella, SW Brisbane; Kenmore, Brisbane; Lake Broadwater, c. 30 km SW Dalby; McFarlane Bridge,

Brisbane valley; Moggill and Brookfield, W Brisbane; Moogoorah Dam; Mt Coolum; slopes of Mt Lindsay; Mt Lindsay, N of farm property; 'Rockwood' property, Chinchilla; Somerset Dam; Samford, N Brisbane; Tarragindi, Brisbane; Upper Samford valley, N Brisbane; Waddy Pt, Fraser Is.; Wishart, Brisbane (AE). NEW SOUTH WALES: Camden; Tubrabulla (MV). Como West, nr Sydney; Glenbrook; Kempsey; Kirrawee, nr Sutherland; Riverstone; South West Rocks (JM). Avoca Beach; Failford, nr Taree; Forster; Goolgowi; 11 km S of Kempsey; Kew; Kempsey; Kincumber; Kyogle; Lane Cove, Sydney; 'Old Bar Park', Old Bar, E of Taree; Port Macquarie; Upper Eden Ck, nr Kyogle; Waitara, Sydney; Wallis L.; Wangaree S.F.; cent. W sect. Yarratt S.F. NE Wingham (MSM).

DESCRIPTION

MALE: Head: Postclypeus shiny black anteriorly, with narrow pinkish-brown margin, and yellow-brown dorsal spot on midline extending on to dorsal surface; short silver pubescence; dorsal surface mainly black with yellow pubescence. Anteclypeus shiny black with conspicuous silver pubescence. Rostrum pallid proximally and deep brown to black apically, with silver pubescence; extends to mid coxae. Mandibular plate black with an outer narrow pale brown marginal ridge, extending to suture between gena; conspicuous silver pubescence. Gena black with conspicuous silver pubescence. Antennae deep brown to black. Ocelli pink-red. Eyes red in live specimens, darkening to reddish-brown or brown in dried specimens (with rare live specimens having white eyes); deep furrow between eyes and pronotum. Dorsal surface of head black with a small, pallid, triangular depressed area between ocelli, anteriorly pointing, and extending to the posterior margin of head; short yellow pubescence, becoming silvery-yellow and more conspicuous behind eyes. Vertex lobes black.

Thorax: Pronotum black; narrow pale brown central fascia, spindle-shaped, not extending to posterior or anterior margins; silvery-yellow pubescence, especially along oblique fissures; pronotal collar brown to reddish-brown, pallid laterally.

Mesonotum mostly black with dark brown dorsolateral, narrow triangular areas, apices inward facing; cruciform elevation brown to pink-brown, black anteriorly; ridges between wing grooves pallid; silver-yellow pubescence, especially conspicuous around cruciform elevation.

Legs: Coxae black with longitudinal pallid fasciae along fore coxae; fore femora pink with broad, dark brown longitudinal fasciae; mid and hind femora deep brown, becoming pallid distally; fore and mid tibiae dark brown, pallid dorsally;

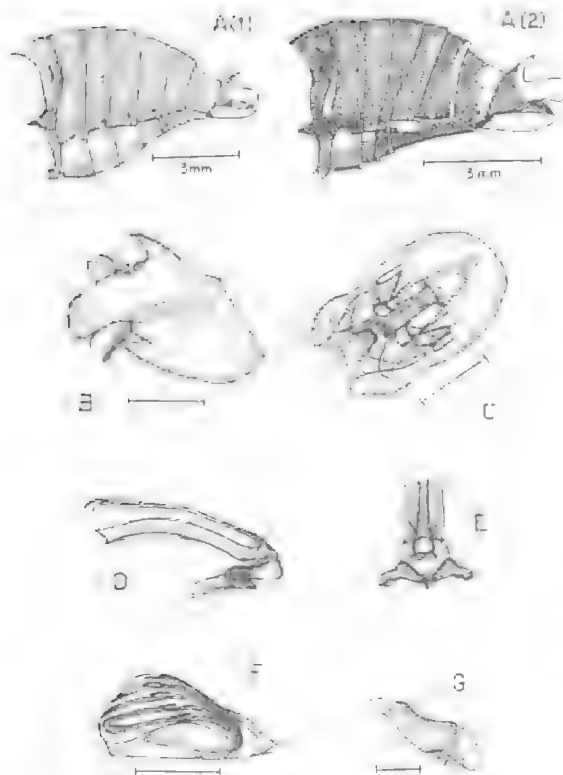


FIG. 42. *Pauropsalta annulata* Goding and Froggatt, ♂♂; A1: Abdomen of specimen from Indooroopilly, Brisbane, viewed from left laterally. A2: Abdomen from lectotype from Southport (ANIC), viewed from left laterally. B to G based on Brisbane specimen. Symbols B to G, and scales, as in Fig. 2.

hind tibiae pallid; tarsi and claws pale brown, being more pallid on hind legs; spines dark brown.

Wings: Fore wing venation pale reddish-brown to brown, becoming darker towards apical cells and ambient veins; fore wing costal veins pale brown; slight angulation of fore wings at node; pterostigma pale reddish-brown; hind wing infuscation spots distinct.

Tymbals: Dorsal ridge extends across dorsal inter-ridge sclerite; two lower ridges joined anteriorly; small but distinct basal spur.

Opercula: Roughly sickle-shaped, obliquely elongated; central region somewhat domed, shiny black; posterior outer region pallid and surface slightly rugose; declivous flange along outer margin; posterior margin rounded; roughly longitudinally undulate i.e. parallel to body axis.

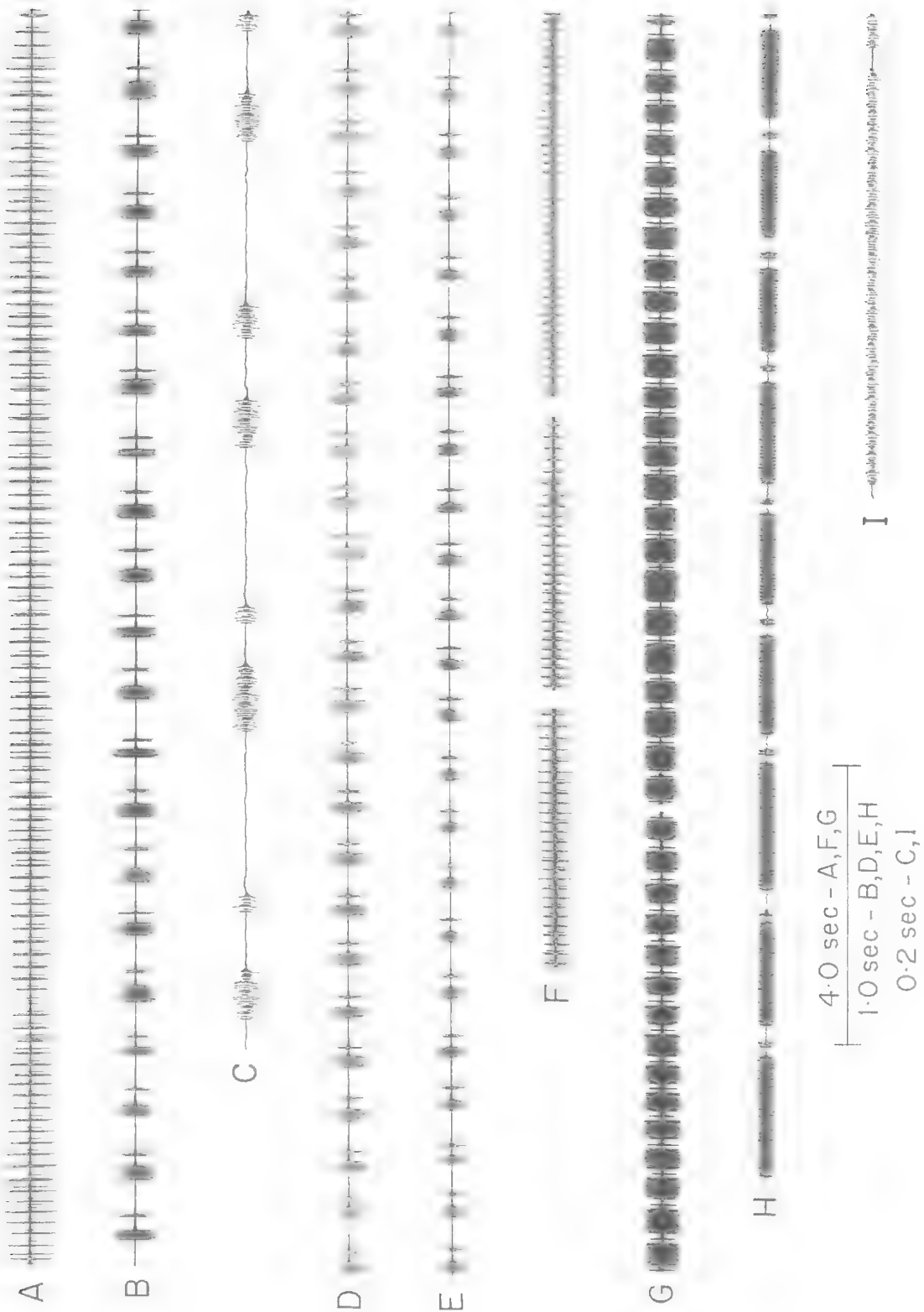
Abdomen: Tergites mainly black with conspicuous yellow to yellow-brown posterior tergite margins between tergites 3 to 7; narrow pale

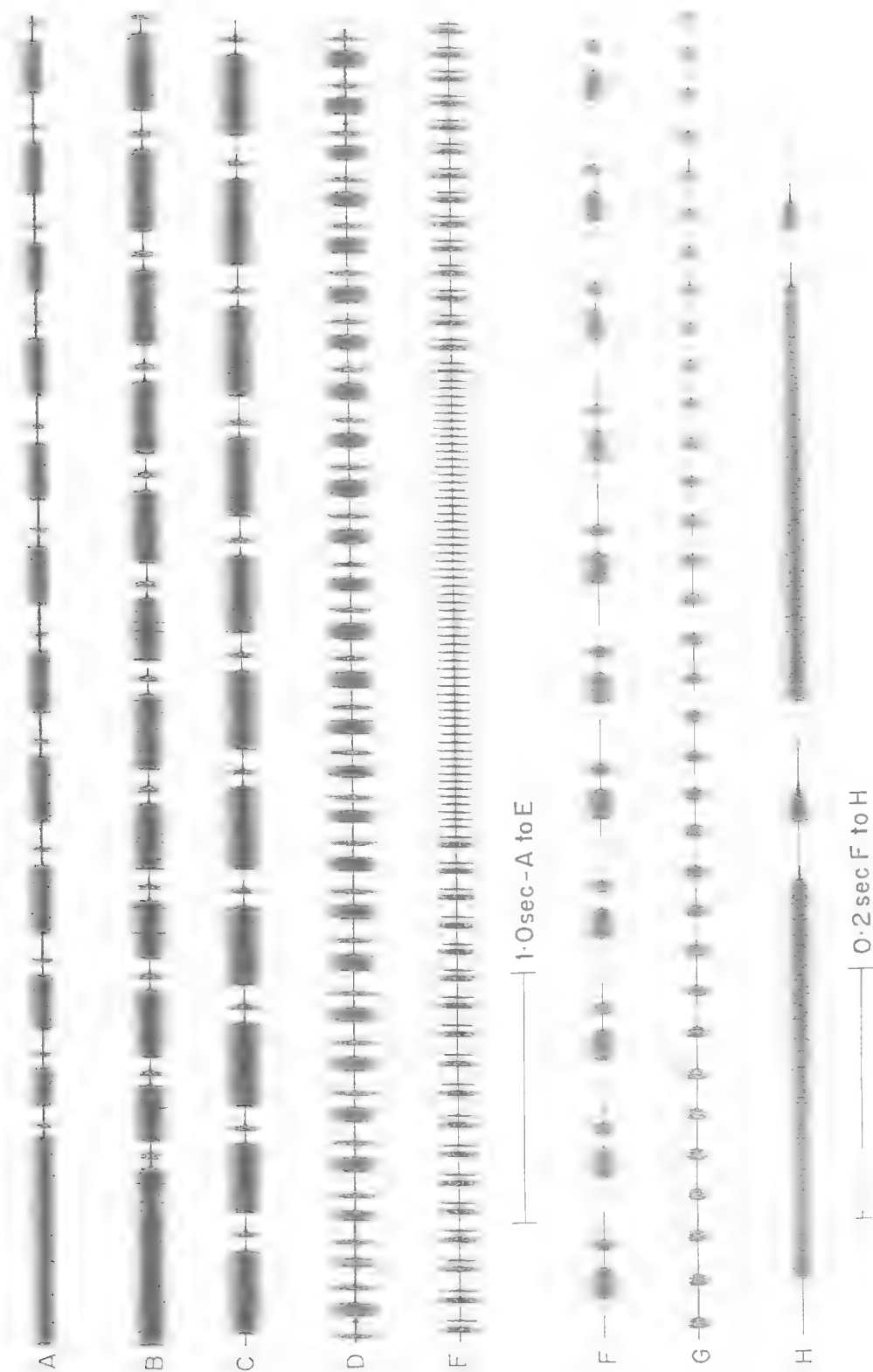
brown zones extending dorsolaterally to lower edges of tergites adjacent to posterior margins of tergites 2 to 7 (very narrow on 2); broad, diffuse, dark brown zone extends around posterior half of tergite 8; silver-yellow short pubescence, especially noticeable laterally, and extending dorsolaterally on tergites 2 and 8. Sternite II mainly black; sternites III to VI yellow-brown with broad, black median areas, becoming more extensive towards sternite VI; sternite VII black, becoming brown posteriorly; posterior margins to sternites yellow-brown, slightly darker medially; sternite VIII medium brown with narrow irregular black anterior region; short silver pubescence, especially noticeable laterally.

Genitalia: Pygophore black anteriorly, brown posteriorly; upper lobes form blinker-like structures, erect, terminally rounded; lower lobes distinct, bulbous; inner lobes enlarged, acute, posteriorly tapering; claspers contain a pair of hooked processes; aedeagus with dorsal pseudoparameres, which bifurcate and join endotheca near gonocoxite IX; pseudoparameres apically curved, tapering; endotheca slightly curved, sclerotised, weakly ornamented apically.

FEMALE: Similar colouration and patterning to male, being generally paler due to less extensive black pigmentation. Head colouration similar to male, except for yellow-brown vertex lobes. Pronotum: Central fascia broader, and extending to anterior margin, the latter brown to yellow-brown; pronotal collar brown to yellow-brown, this colouration extending dorsolaterally either side of central fascia to form a pair of outward-pointing, wedge-shaped patterns. Mesonotum: Black with brown to yellow-brown median, dorsolateral, and lateral fasciae, each wider than in male, resulting in a greater extent of dorsolateral and lateral brown to yellow-brown colouration. Legs similar to male, with tarsi somewhat paler. Abdomen: Tergites similar to male; tergite 9 sandy-brown with a pair of longitudinal near-dorsal black fasciae which extend to, and laterally down the anterior edge; sternites sandy-brown with a broad and more or less regular median black fascia from sternites II to VII; ovipositor sheath

FIG. 43. Oscillograms of calling songs of *P. annulata* from: A to C, Indooroopilly, Brisbane (Feb. 1978); D, E, Mt Coolum, southern Queensland (Oct. 1981; D is red-eyed type; E, white-eyed type); F, Hervey Bay (JM); G to I, Upper Samford valley, northern Brisbane. A to F represent the normal song pattern; G to I represent the extended song pattern. Three time scales are shown.





extends approximately 0.5-1 mm beyond termination of tergite 9.

MEASUREMENTS: 54♂♂ and 22♀♀. Body length: ♂ 11.2-15.2 (13.40); ♀ 12.4-16.0 (14.36). Fore wing length: ♂ 14.0-17.8 (15.69); ♀ 15.2-18.3 (16.95). Head width: ♂ 3.8-4.8 (4.41); ♀ 4.1-5.1 (4.64). Pronotum width: ♂ 3.0-4.0 (3.57); ♀ 3.3-4.1 (3.71). Abdomen width: ♂ 3.6-4.4 (3.95); ♀ 3.3-4.3 (3.89).

COMMENTS

Two male syntypes of *Pauropsalta annulata* are held in ANIC. One is labelled 'Southport' and is selected as lectotype. The second specimen is from Townsville (December, 1902, F.P. Dodd) but, with damage to the genitalia and some mould coverage, is not as well preserved as the Southport specimen. The two syntypes are not conspecific: the Townsville specimen is *P. ayrensis*. In the original description of *Pauropsalta annulata*, Goding and Froggatt, 1904, refer to six additional syntypes (in MM). The additional localities were Gatton and Gin Gin (Queensland); Narromine and Wagga (New South Wales).

Pauropsalta annulata was synonymised by Distant (1906b:178) with *Pauropsalta encaustica*, a synonymy rejected by Metcalf (1963:405), but not by Duffels and van der Laan (1985:300).

This species can be distinguished from *P. corticinus*, *P. fuscata* and *P. siccanus* by the more strongly banded abdomen, the very pale, ascending, and non-hooked upper pygophore lobes (male), and the red eyes in fresh specimens (with relatively rare exceptions). Females may also be distinguished by the paler coloured tergite 9, and the relative length of the ovipositor sheath (extending <0.5 mm beyond tergite 9 in *P. corticinus*, *P. fuscata* and *P. siccanus*; >0.5 mm in *P. annulata*). *P. annulata*, however, is closest to *P. ayrensis*, and both species extensively overlap in range, although differing in their songs and habitat preferences. The males can usually be distinguished by colouration of the tergite margins

(yellow to yellow-brown in *P. annulata*; orange to orange-brown in *P. ayrensis*); shape of pygophore upper lobe (broad, rounded termination in *P. annulata*; slightly hooked termination in *P. ayrensis*); colour of eyes in fresh specimens (normally red in *P. annulata*; dark reddish-brown to black-brown in *P. ayrensis*); and shape of endotheca (Figs 42D, 46D), this being the most diagnostic character (broadened apically, i.e. 'trumpet-like' in *P. ayrensis*; curved and cylindrical in *P. annulata*). Females differ in colouration of tergite margins and eyes (as above), and relative ovipositor sheath lengths (extending 0.5-1 mm beyond tergite 9 in *P. annulata*; not extending significantly beyond tergite 9 in *P. ayrensis*).

DISTRIBUTION

Widely distributed along eastern New South Wales from Sydney north to the Rockhampton area, central Queensland (Fig. 59). It is common on the Carnarvon Gorge and Tableland, and on the Blackdown Tableland. Aural records suggest that it extends inland to the Warrumbungles and Narrabri regions of central northern New South Wales. In Queensland, it occurs commonly in open dry sclerophyll forest, including suburban parks and gardens. It also occurs on the coastal fringe in casuarinas and melaleucas (see also Goding and Froggatt, 1904: 620-621), especially where these extend inland to open forest communities. Records occur between September to March.

SONG

Extensive variation of the calling song of *P. annulata* has been observed and illustrates the problem of using song as a diagnostic taxonomic character; it also raises the question (in the absence of direct experimental data) of the acoustic characteristics by which this cicada can recognise its own song patterns.

The common southeastern Queensland song consists of a series of alternating 'long' and 'short' phrases (each associated pair of phrases being here called a phrase group), which are continually and monotonously repeated. Two main song variants are recognised, based on the relative duration of the 'long' phrase; this can either be relatively short (i.e. 33-70 msec; referred to here as normal song), or relatively long (150-450 msec; referred to here as extended song). Each phrase group is defined as a 'long' phrase plus the following short phrase, the latter always <30 msec. Details of the phrase lengths, and intervening durations, are listed in

FIG. 44. Oscillograms of calling songs of *P. annulata* from: A, Kirrawee, Sydney (JM); B, C, H, Carnarvon Lodge, entrance to Carnarvon National Park (Dec. 1985; songs from two separate specimens); D, Blackdown Tableland (Dec. 1985); E to G, northern base of Blackdown Tableland (Charlevue Ck; F represents the extended time scale of the 'chirping' song phase, while G represents the extended time scale of the 'buzzing' song phase). Records shown at two time scales. A to C, and H represent extended song pattern; D to G represent normal song pattern.

Table 5, this being based on detailed oscillogram measurements of ten separate sets of calling songs. It is evident that even apart from the two major song variants, variations in the frequency of phrases and interphrase intervals occur, both within and between individual insects (noting also that each song was taped with captured insects recorded under comparable conditions of lighting and temperature). A further variation in the calling songs is the apparently random occurrence of a very long, continuous phrase, occasionally interspersed with the more normal song patterns; this is illustrated (in part) in the initial parts of the oscillogram shown in Figure 44A,B, and can occur in either the normal or extended songs.

The unresolved difficulty of the two major song variants is their distinctive regional occurrence. For example, the normal song is that most commonly heard throughout southeastern Queensland (eg. Fig. 43A-F); in two local areas around Brisbane, however, the extended song

seems to strongly predominate, one being Brookfield (W. Brisbane), the second being the upper Samford valley, extending to Mts Nebo and Glorious (N and NW of Brisbane; see Fig. 43G-I). The Sydney region is also characterised by the extended song (Fig. 44A; JM, pers. comm.). In the lower Carnarvon Gorge, the extended song is typical (Fig. 44B,C), whereas on the associated tablelands, the normal song is heard. On Blackdown Tableland, only the normal song is encountered (Fig. 44D). No significant morphological differences have been found in specimens representing these various 'song' populations. Moreover, on occasions in Brisbane, the extended song has been heard emitted by individuals otherwise singing the normal calling song. Thus, there is currently no compelling evidence to support the existence of two sibling species, and thus *P. annulata* is treated as a single species.

Expanded time scale oscillograms enable the

TABLE 5. Comparative data on calling song patterns of *P. annulata*.

	Brisbane		Mt Coolum		North Brisbane	Sydney	Carnarvon Gorge	Blackdown Tableland	Base of Blackdown Tableland
	Indoor-oopilly 16.ii.1978	Chelmer 20.xi.1980	White-eyed variety 17.x.1981	Normal red-eyed type 17.x.1981	Upper Samford Valley 1.xi.1979	Kirrawee	11.xii.1989	17.xii.1985	17.xii.1985
1. Duration of long phase (msec)	33-39 (38) [rarely 48]	40-46 (49)	45-63 (49)	41-50 (48)	290-450 (340)	150-280 (225)	230-310* (276) 310-370* (325)	40-70 (61)	24-25 (24)
2. Duration of short phase (msec)	12-17 (14) [rarely 25-26]	12-19 (15)	16-20 (18)	16-19 (17)	25-30 (27)	20-22 (21.5)	20-25 (23)	19-20 (20)	8-10 (8.6)
3. Duration between long phrases (msec)	150-180 (170)	130-170 (150)	120-160 (140)	150-170 (160)	100-160 (120)	145-190 (175)	110-150* (130) 140-190* (160)	120-190 (135)	70-74 (72)
4. Duration between long and short phrases or single phase group (msec)	29-40 (38)	27-41 (31)	21-35 (29)	26-30 (28)	19-45 (35)	40-50 (49)	38-50* (44) 45-52* (49)	36-50 (40)	11-15 (13)

* Different individuals

finer scale structures of the songs to be seen (see especially Fig. 43C,I,44H). The phrases can be resolved into compound pulse groups containing superimposed high and low amplitude pulses; the pulse repetition frequency of the high amplitude pulse is estimated to be approximately 600 Hz. Each pulse group lasts approximately 12 msec, and each is modulated with respect to the high amplitude pulses, with the modulation frequency estimated to be 82 Hz (see especially Fig. 44H).

The final calling song variation is illustrated in Figure 44E-G, from the northern base of the Blackdown Tableland. This song is generally close to the normal song (although phrases and inter-phrase intervals are shorter; Table 5), but it has additional, regularly interspersed 'buzzing' phrases, as shown in Figure 44E, which consist of short, regular phrases (duration 8.3 msec) with intervals of 23 msec. In this case, the possibility that this population is an unrecognised sibling species cannot be excluded; although the external colouration and external morphological characters of the population are typical of *P. annulata*, the male pygophore has rudimentary spur-like processes extending from the lower lobes.

***Pauropsalta ayrensis* n.sp.**
(Figs 45C,D,46,47,59)

MATERIAL EXAMINED

HOLOTYPE: 3 QUEENSLAND: Alva Beach, Ayr, Jan. 1961, A. Ewart (QM, Reg. No. T.9189).

PARATYPES: QUEENSLAND: 2♂♂, Biggenden Bluff Range, 13.xii.1970, H. Frauca, Euc. woodland; 1♀, Biggenden Bluff Range foothills, 1-7.i.1972, H. Frauca, 1♂, 9.xii.1972; 2♂♂, Burnett R., N of Eidsvold, 330 ft, 9.i.1970, at light, EB/GH/IM; 1♂, 1♀, Milmeran to Cecil Plains, x.1936, K.H.L. Key; 6♂♂, 2♀♀, Foothills of Mt Walsh N.P., 10 km S by E of Biggenden, 1-2.i.1972, H. Frauca; 1♂, Townsville, xii.1902, F.P. Dodd (labelled as syntype of *Pauropsalta annulata*, Goding and Froggatt; ex MM, 'on permanent loan' to ANIC); 1♀, Yeppoon, 14.xii.1964, I.B.F. Common, 1♂, 28.xii.1964 (ANIC). 2♂♂, Townsville, 20.i.1901, F.P. Dodd, 1902-319; 1♀, Townsville, ii.1903, F.P. Dodd, 1904-27; 1♀, Townsville, no date, F.P. Dodd, 1904-284; 3♂♂, 1♀, Westwood nr Rockhampton, 7.iii.1924, 360 ft, G.H. Wilkins (BMNH). 1♂, Townsville, 16.i.1969, R. Monroe (QM). 2♂♂, 1♀, Greta Ck, 20 mi. N of Proserpine, 1.i.1965, G. Monteith (UQIC). 1♀, Bowen, 8.xi.1973, Meurant; 23♂♂, 1♀, Bowen, 23.xii.1980, J.T. Moss; 1♀, Bowen, 3.xii.1981, J.T. Moss; 2♂♂, 2♀♀, Cathu S.F., N of Mackay, 3.xii.1981, J.T. Moss; 1♂, The Caves, Rockhampton, 2.xii.1981, J.T. Moss; 13♂♂, 5♀♀, Goomeri, 24.xii.1982, J.T. Moss; 1♂, 3 m(l) E of Marlborough, 4.xi.1972, (cow dung), R.I. Storey; 4♂♂, 1♀, Somerset Dam, 30.xii.1973, J.T. Moss (JM). 1♂, 1♀, Ayr, 12.i.1972, A.E.; 4♂♂, Bowen, 2.ii.1973, A. and M.

Walford-Huggins; 8♂♂, 5♀♀, Duaringa, xii.1983, E.E. Adams; 3♂♂, 2♀♀, Edungalba, 5.xii.1979, [Black Eyes], M.S. and B.J. Moulds; 1♂, 2♀♀, Edungalba, nr Duaringa, 2.xii.1981, G. and J. Burns, 1♀, 3.xii.1981; 1♂, 'Mourangee' Hsd, nr Edungalba, at light, 16.i.1983, E.E. Adams, 1♂, 19.i.1983, E.E. Adams; 1♀, 2 km E of 'Mourangee' Hsd, nr Edungalba, 23.i.1983, E.E. Adams; 1♂, 'Mourangee', nr Edungalba, 5.xii.1983, E.E. Adams; 1♀, 5 km SW of 'Mourangee' Hsd, nr Duaringa, 24.xii.1983, E.E. Adams; 1♂, 2♀♀, 'Mourangee', nr Edungalba, xii.1983, E.E. Adams, 1♂, [Blackish Eyes], 10.xi.1984, 5♂♂, 1♀, on tea-tree flowers, 12.xi.1985, 1♀, on sandlewood, 14.xii.1985; 2♂♂, 2♀♀, 3 km SW of Mourangee Hsd nr Edungalba, 3.xi.1986, E.E. Adams, 3♂♂, 2♀♀, 7.xi.1986; 3♂♂, 2♀♀, 'Mourangee' nr Edungalba, 13.xi.1987, E.E. Adams, 1♀, on red soil tableland, 14.xi.1987; 1♀, 5.3 km E of Mourangee Hsd, nr Edungalba, on 1 m high bush, 18.xi.1987, Robert Adams; 2♀♀, Rockhampton, 5.ii.1973, at light, A. Atkins, 1♂, 9.ii.1973; 1♀, Rockhampton, 16.xii.1977, A. Miller; 1♀, St Margarets Ck, c. 20 m(l) S Townsville, 1.ii.1973, A. and M. Walford-Huggins; 7♂♂, 13♀♀, Tinaroo Falls Dam, Atherton Tableland, 12.ii.1986, D. Lane; 1♀, Townsville, 7.i.1987, M.S. and B.J. Moulds; 1♂, Yeppoon, 28.i.1983, R. Eastwood (MSM). 1♂, Alva Beach, Ayr, (recorded), 29.i.1981, A.E.; 3♂♂, Ayr, low trees/shrubs after rains, 12.i.1972, A.E.; 1♂, 1♀, Ayr, i.1981, A.E.; 2♂♂, 1♀, Round Hill Head, 19.i.1981, T.H. Cribb; 1♂, S Mole Is., Whitsunday Group, 20.v.1987, A.E.; 1♂, Splitters Ck, Somerset Dam, 5.i.1979, A.E. (AE).

ETYMOLOGY

Derived from the town of Ayr, northern Queensland, where this species was first recognised, and where it is common.

DESCRIPTION

MALE: Head: Mainly black. Postclypeus shiny black anteriorly with narrow pale brown lateral margin, together with very small pale brown dorsal spot on midline; dorsal surface black; yellow and silver pubescence present. Anteclypeus shiny black with silver pubescence. Rostrum brown becoming darker apically; extends to mid coxae. Dorsal surface of head shiny black with slightly depressed triangular pallid area between ocelli, apex anteriorly pointing, and base extending to posterior margin of head; silver and yellow pubescence sparsely distributed, with conspicuous silver pubescence behind eyes. Antennae black with paler apical terminations. Ocelli pink to red. Eyes dark reddish-brown to black-brown. Vertex lobes black, each with small dorsal pallid marking.

Thorax: Pronotum shiny black, grading to deep brown adjacent to central fascia; central fascia pale yellow-brown and not always extending to

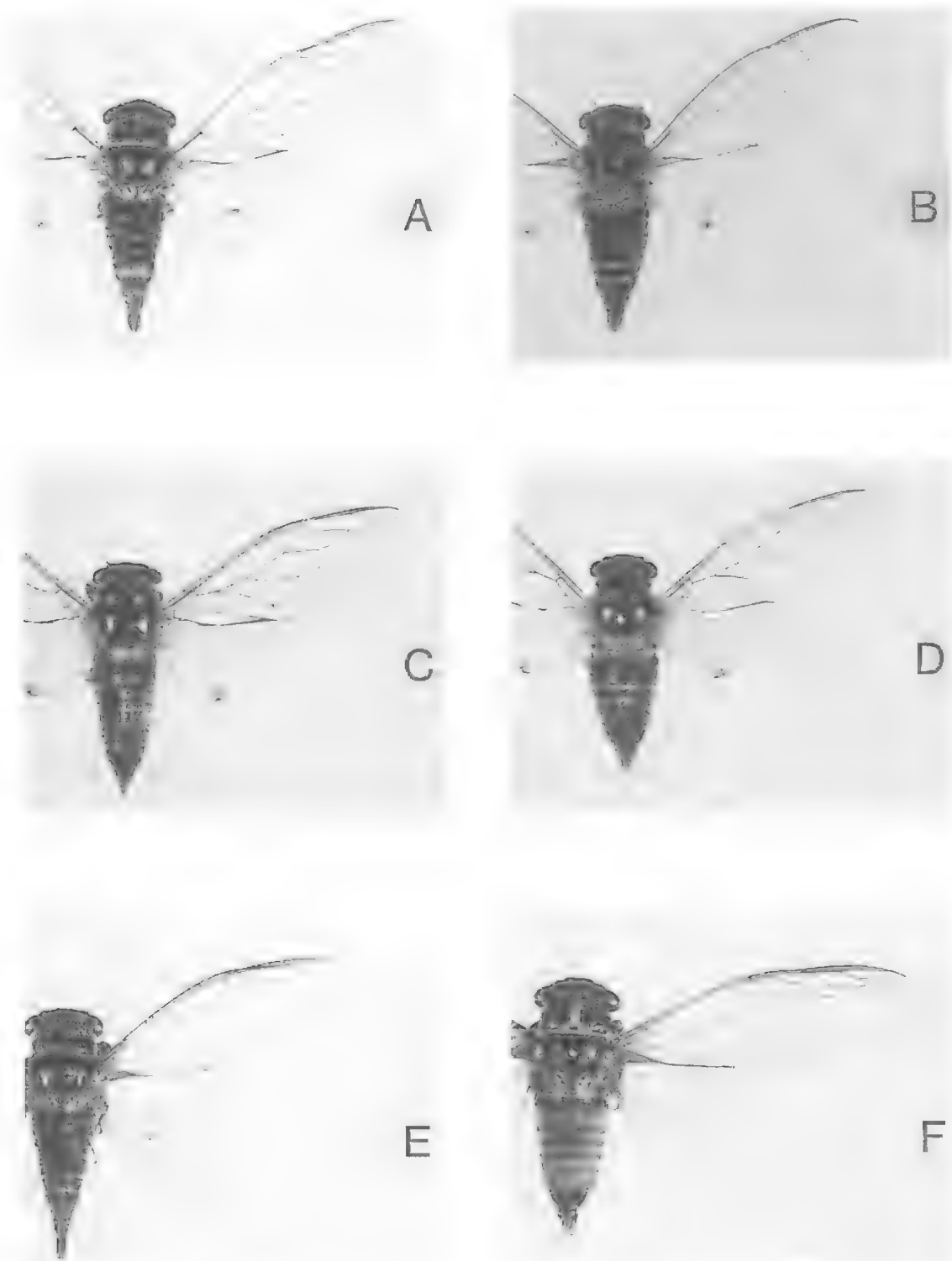


FIG. 45. A,B *P. annulata* ♀, ♂. C,D *P. ayrensis* ♀, ♂. E,F *P. eyrei* ♀, ♂. Each photograph $\times 2$ natural size.
Photographs: D.M. Reeves.

pronotal collar; short yellow pubescence present except adjacent to central fascia; pronotal collar and ridge along the anterior margin of pronotum are pale yellow to pale brown.

Mesonotum black with pale yellow-brown to orange-brown cruciform elevation (black anteriorly), extending to ridges between wing grooves, and to basal membranes of fore wings; silvery yellow pubescence, most conspicuous around cruciform elevation.

Legs: Coxae dark brown, distally paler; femora dark brown, distally paler; tibiae, tarsi, claws, and spines of fore legs dark brown; mid and hind tibiae and tarsi generally pale yellow-brown, with dark brown claws.

Wings: Costal veins of fore wings pale to medium brown, with remaining venation medium to dark brown, becoming darker towards the apical cells and ambient veins; pterostigma dark brown; infuscation spots on hind wings clearly defined.

Tymbals: Dorsal ridge extends across dorsal inter-ridge sclerite; lower two ridges joined anteriorly; small but distinct basal spur.

Opercula: Roughly sickle-shaped, obliquely elongated; median area shiny black, somewhat domed; posterior region pale sandy-brown with finely rugose surface; declivous flange around outer margin; posterior termination of opercula rounded; silver pubescence variably present; broadly longitudinally undulate i.e. parallel to body axis.

Abdomen: Tergites shiny black with prominent orange-brown to orange posterior margins to tergites 3 to 8, also extending along lower margins; these orange margins widest dorsolaterally and laterally; short silver-yellow pubescence sporadically developed, especially dorsolaterally and laterally. Sternite II black; sternites III to VII orange, each with median black area, not always extending across posterior margins of sternites; dark pigmentation most extensive on sternite VII; sternite VIII orange-brown with anterior, dorsolateral black pigmentation; silver pubescence present.

Genitalia: Pygophore brown, becoming black dorsally and anteriorly; upper lobes erect, and somewhat widened and flattened terminally with slightly hooked termination; lower lobes distinct; inner lobes somewhat enlarged, elongated, apically acute, and posteriorly pointing; claspers contain a pair of hooked processes; beak distinct and acute; aedeagus with dorsal pseudoparameres which bifurcate and join the endotheca near to gonocoxite IX; pseudoparameres tapering,

apically acute, slightly undulate; endotheca broadened apically (i.e. 'trumpet-like') with minor apical ornamentation.

FEMALE: Colouration and markings of head, thorax, legs, wings similar to male, with slightly darker venation on fore wings. Abdomen: Similar to male; zones adjacent to posterior margins of tergites 3 to 8 orange-brown to orange, not extending to lower edges; tergite 9 orange-brown laterally, with black dorsal fascia (formed by coalescence of a pair of dorsolateral fasciae) which broadens and extends around anterior margin of tergite. Sternites II to VII brown to orange-brown, each with diffuse median dark region not extending across individual sternite margins; ovipositor sheath not extending significantly beyond termination of tergite 9.

MEASUREMENTS: 36♂♂ and 8♀♀. Body length: ♂ 12.7-16.0 (14.11); ♀ 13.0-15.2 (14.19). Fore wing length: ♂ 14.7-18.3 (16.19); ♀ 15.5-17.8 (16.83). Head width: ♂ 3.9-4.6 (4.28); ♀ 4.2-4.6 (4.38).

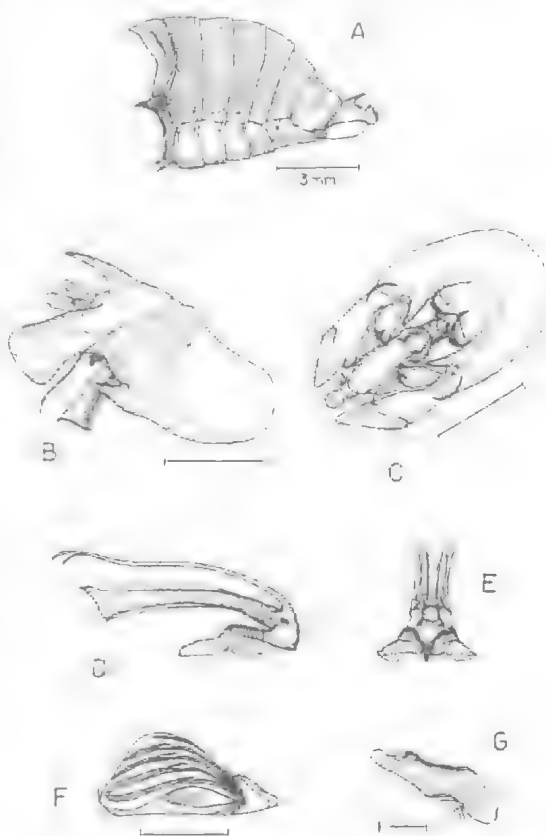
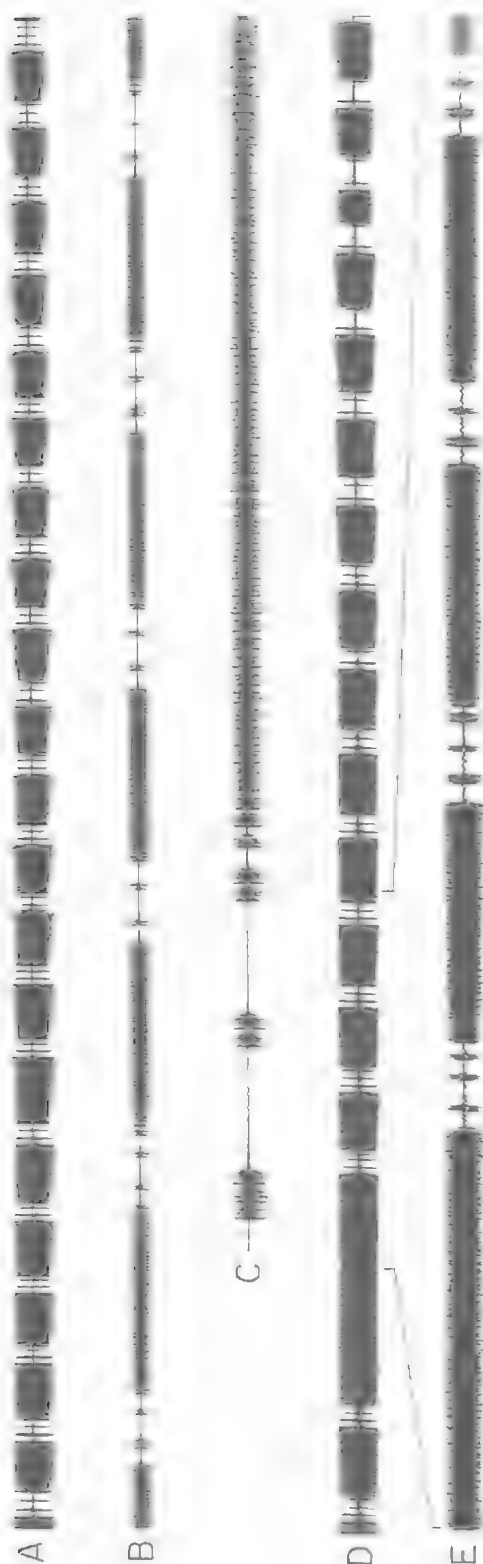


FIG. 46. *Pauropsalta ayrensis* sp.n., ♂, from Ayr, northern Queensland. Symbols A to G, and scales, as in Fig. 2.



Pronotum width: ♂ 3.2-4.0 (3.61); ♀ 3.6-3.9 (3.66).
Abdomen width: ♂ 3.6-4.6 (4.11); ♀ 3.6-4.3 (3.95).

COMMENTS

P. ayrensis and *P. annulata* are closely similar and distinguishing features are given under *P. annulata*. This species is also similar to *P. corticinus*, *P. fuscata* and *P. siccanus*. Males of *P. ayrensis* are most easily distinguished by their brown, ascending, and slightly hooked pygophore upper lobes (compare Fig. 46B with 16B, 19B-22B, and 26B) and by the orange-brown to orange tergite margins. Females, however, may be more difficult to distinguish, but the orange-brown to orange tergite margins are usually characteristic of *P. ayrensis*.

DISTRIBUTION

Along eastern Queensland from the Atherton Tableland southwards to Somerset Dam and Milmeran in southeastern Queensland (Fig. 59). In the northern part of its range, it occurs on or near the coast, but occurs further inland in its southern range. Its habitat is variable and includes open dry forest, open shrubland, suburban gardens and parkland, and also coastal dunes. It rests and sings in isolated trees and shrubs, both on the trunks and outer foliage, and also frequently in long grass, tending to occur lower down than *P. annulata*, although as shown in Figure 59, their ranges overlap. Records occur between October to May.

SONG

Ayr song: Consists of a series of two or three short phrases, followed by a long phrase; there is a slight rise of amplitude during the progress of the long phrase (Fig. 47). All phrases, when examined on the expanded time scale, are seen to comprise pulse groups showing an amplitude modulation with a frequency of 81-86 Hz; the duration of the pulse groups range between 10-14

FIG. 47. Oscillograms of calling songs of *P. ayrensis* from: A to C, Alva Beach, Ayr (Jan. 1981); D, E, Splitters Ck, Somerset Dam (Jan. 1979). Records shown at three time scales.

msec. Pulse repetition frequencies are estimated between 400-425 Hz.

The short phrases consist mostly of double pulse groups, but may less commonly consist of one or three pulse groups. Each pulse group itself consists of four compound pulse subgroups, these not being clearly resolvable from the available data. Lengths of the long phrases varies between 0.70-0.92 sec (av. 0.72), with intervals between long phrases varying between 0.20-0.38 sec (av. 0.28).

Somerset Dam Song (S Queensland): This is similar in overall structure, although in the recorded song, the phrases are not so clearly resolved into the pulse groups. Duration of the long phrases varies between 0.64-0.90 sec (av. 0.77), rarely extending to greater than 3 sec; intervals between long phrases range between 0.26-0.48 sec (av. 0.33).

***Pauropsalta eyrei* (Distant) n.comb.**
(Figs 45E,F,48,49,59)

Melampsalta eyrei Distant 1882:130, Pl.VII, Figs 12, 12a-b; Goding and Froggatt, 1904:654; Distant, 1906b:175; Froggatt, 1907:354; Ashton, 1914:353; Kato, 1932:187; Burns, 1957:652; Duffels and van der Laan, 1985:284.

Cicadetta eyrei (Distant) Metcalf, 1963:312; Weidner and Wagner, 1968:149; Dugdale, 1972:879.

MATERIAL EXAMINED

HOLOTYPE: ♂ of *Melampsalta eyrei* in BMNH: Peak Downs (no date). Weidner and Wagner (1968:149) list ♂♂ 'syntypes' in the Hamburg Museum that have not been examined.

OTHER MATERIAL: 155 specimens from following localities. QUEENSLAND: Archer's Ck, Mt Garnet Road; Barron Falls, Kuranda; Biggenden; Biggenden, Bluff Range Foothills; Pistol Gap S of Byfield; Townsville; Yeppoon (ANIC). Annan R.; Cairns; Cooktown; Kuranda; N Queensland; Pine Ck nr Cairns; Ravenshoe (BMNH). Cairns; Claudie R.; Coen, Cape York; Daintree R.; Dunk Is.; Kuranda; Meringa; Silver Plains, Coen (MV). Cairns; Mt Isa Mines; Rodds Bay; Tully; Yeppoon (UQIC). Barron Falls, Kuranda; Cairns; Cooktown; 19.25S 144.20E, Einasleigh R., 22 km S by W of Lyndhurst Hsd; Georgetown; Gilbert R. via Goergetown; Rungoo Mt Range, 20 km N of Ingham; Station Ck, nr Mt Carbine; Townsville; Waterfall Ck, 20 mi. N of Rollingstone (JM). Bald Hills Stn, 30 km N of Cooktown; Butcher Ck, 20 km W of Cloncurry; Townsville (MSM). Ayr; Carnarvon Lodge, entrance to Carnarvon Gorge; 'Early Storms', nr Carnarvon N.P.; 'Rewan', nr Carnarvon N.P.; S Molle Is. (AE).

DESCRIPTION

MALE: Head: Postclypeus shiny black anteriorly with clearly defined orange-brown margin, extending between transverse ridges, and

triangular orange-brown patch dorsally on midline; dorsal surface black; yellowish pubescence. Anteclypeus black with silver-yellow pubescence. Rostrum pale brown, becoming dark brown to black apically; extends to mid coxae. Gena and mandibular plate black, with small pale orange-brown triangular area along intervening suture adjacent to postclypeus, and a pallid marginal ridge to mandibular plate; conspicuous silver-yellow pubescence. Antennae dark brown. Vertex lobes orange-brown. Dorsal surface of head shiny black with small triangular pallid depressed area on longitudinal suture between ocelli; yellowish pubescence behind eyes.

Thorax: Pronotum dark brown to black with sharply defined pale yellow-brown to orange anterior margin, pronotal collar, and broad central fascia, the latter broadening anteriorly and especially posteriorly adjacent to the anterior margin and pronotal collar, respectively; sparse yellowish pubescence.

Mesonotum black with a pair of sharply defined irregular dorsolateral yellow-brown to orange

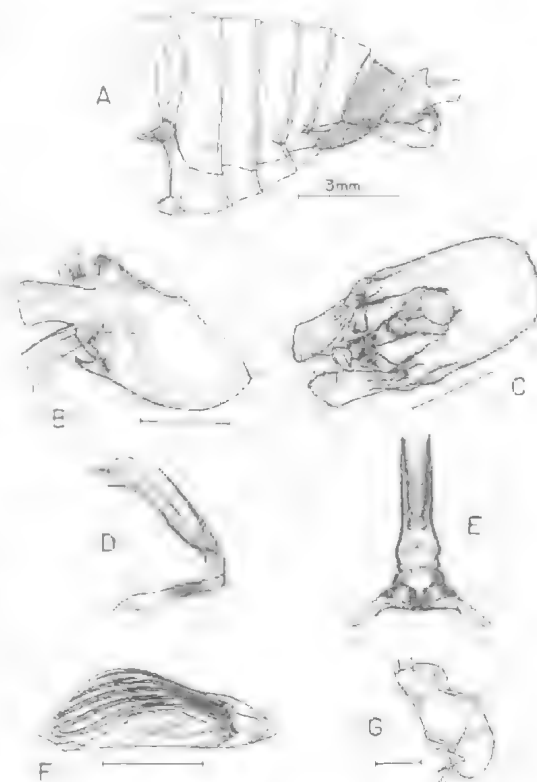


FIG. 48. *Pauropsalta eyrei* (Distant) comb.n., ♂, from Cooktown, northern Queensland. Symbols A to G, and scales, as in Fig. 2.

fasciae, broadening inwards and almost coalescing medially; a pair of broad oblique lateral yellow-brown to orange fasciae join the dorsolateral fasciae adjacent to anterior region of cruciform elevation; cruciform elevation yellow-brown with black anterior area; yellowish pubescence conspicuous adjacent to wing grooves.

Legs: Coxae yellow-brown to orange-brown with narrow dark brown dorsal margins; remaining colouration orange to yellow-brown, with dark brown tips to claws and spines.

Wings: Venation very pale brown, becoming darker brown distally and along ambient veins; infuscation spots on hind wings faintly developed, and absent along vein 1A + 2A of fore wings.

Tymbals: Dorsal ridge extends across dorsal inter ridge sclerite; lower two ridges joined anteriorly; distinct basal spur.

Opercula: Broadly sickle-shaped, longitudinally undulate, with rounded inward (posterior) terminations; gently domed and shiny median area; declivous marginal flange best developed along outer margin; colour orange-brown except for diffuse brownish area adjacent to anterior margin; surface finely rugose.

Abdomen: Tergites 2 to 7, and sternites II to VI, yellow to orange, with only a small brown marking dorsally and dorsolaterally on tergite 2; tergite 8 dominantly black with narrow irregular anterior and posterior orange-brown dorsal margins; sternite VII mostly dark brown to black, paler along anterior margin; sternite VIII dark brown to black anteriorly, grading orange-brown posteriorly.

Genitalia: Pygophore deep brown anteriorly, becoming yellow-brown adjacent to, and including upper lobe; upper lobe with more or less oblique flat terminations (as viewed laterally); inner lobe conspicuously raised, acutely tapering, and posteriorly pointing; lower lobe slightly raised; small hooked claspers; dorsal pseudoparamers shorter than endotheca, and bifurcating and joining endotheca near (but not adjacent to) gonocoxite IX; endotheca markedly enlarged apically, with pair of small terminal lateral spikes.

FEMALE: Head, thorax, legs, wings, and sternites as in male. Tergites orange to orange-brown with dorso-anterior black markings which narrow and terminate dorsolaterally on tergites 3 to 8; tergite 9 orange-brown to medium brown with pair of dark brown longitudinal dorsolateral fasciae which join posteriorly, but not extending to posterior tergite margin; ovipositor sheath extends approximately 1-1.5 mm beyond termination of tergite 9.



FIG. 49. Oscillograms of calling song of *P. eyrei* from Townsville. Two time scales are shown.

MEASUREMENTS: 18♂♂ and 13♀♀. Body length: ♂ 13.2-17.0 (15.38); ♀ 15.8-18.8 (17.25). Fore wing length: ♂ 14.7-20.3 (19.02); ♀ 19.6-22.4 (20.89). Head width: ♂ 4.1-5.6 (4.96); ♀ 4.8-5.6 (5.33). Pronotum width: ♂ 3.3-4.6 (4.10); ♀ 3.8-4.6 (4.26). Abdomen width: ♂ 3.6-4.8 (4.26); ♀ 3.6-4.8 (4.08).

COMMENTS

The colouration and size (Fig. 1) of this insect are distinctive.

DISTRIBUTION

From the Biggenden and Carnarvon Gorge areas in southern central Queensland, northwards to Iron Range, Cape York Peninsular, and westwards towards the Gulf Country, with northwestern records near Cloncurry and Mt Isa (Fig. 59). Habitat preference is for dry, relatively short, open forest and semi-grassland.

SONG

A single recording from Townsville (JM) consists of a continuous train of repeated phrases, with no apparent systematic variation in pattern (Fig. 49). Each phrase has a duration of 16-18 msec, with interphrase intervals of 10-12 msec. The expanded time scale oscillogram, although of limited resolution, indicates that each phrase can be resolved into ten distinct pulses.

P. AQUILUS SPECIES-GROUP

Two species are recognised in this group, only one of which occurs in Queensland (*P. aquilus*). The second is *P. infusata* (Goding and Froggatt), currently known only from South Australia. Both are relatively small cicadas (12-17 mm body length), almost entirely black and thus highly cryptic. The male genital structures suggest closer affinities with the *annulata* group than with the other species-groups, but marked differences nevertheless exist.

Pauropsalta aquilus n.sp. (Figs 50, 51, 52E, F, 59)

Pauropsalta species D Ewart, 1988:181, 182, figs 2, 9D, Pl. 1F.

MATERIAL EXAMINED

HOLOTYPE: ♂ QUEENSLAND, Mon Repos nr Bundaberg, 19.xii.1983, (Recorded on tape), A. Ewart (QM, Reg. No. T.9190).

PARATYPES: QUEENSLAND: 1♂, 1♀, Mon Repos, nr Bundaberg, 19.xii.1983, A.E. (ANIC). 1♂, 1♀, L. Broadwater, 30 km SW of Dalby, 12.ii.1984, A.E.

(BMNH). 1♂, 1♀, L. Broadwater, 30 km SW of Dalby, 12.ii.1984, A.E. (MNDN). 1♀, Mon Repos, nr Bundaberg, 19.xii.1983, A.E. (QM). 1♂, 1♀, Carnarvon N.P., 8.xii.1979, mv lamp, G. Daniels, M.A. Schneider; 2♂♂, 1♀, Carnarvon N.P., 8-10.xii.1979, M.A. Schneider, G. Daniels; (UQIC). 2♂♂, 2♀♀, Carnarvon N.P. nr Rolleston, 20.i.1973, J.T. Moss; 14♂♂, 6♀♀, Carnarvon Gorge, 8-12.xii.1985, J.T. Moss and A.E.; 5♂♂, 2♀♀, Curtis Is. nr Gladstone, 30.x.1983, J.T. Moss; 3♂♂, 2♀♀, L. Elphinstone, nr Glenden, 20-29.ii.1984, J.T. Moss; 1♂, 1♀, Toogoom, Hervey Bay, 18.x.1983, J.T. Moss (JM). 3♂♂, Campaspe R. crossing, WSW of Charters Towers, 16.i.1984, (light grey eyes), M.S. and B.J. Moulds; 1♀, L. Broadwater nr Dalby, site F, 27°21'S 151°06'E, 25.xii.1986, G. and A. Daniels, 1♀, site B, 30.i.1987, 1♀, site F, 31.i.1987; 2♂♂, L. Broadwater, via Dalby, 9.xii.1987, Monteith and

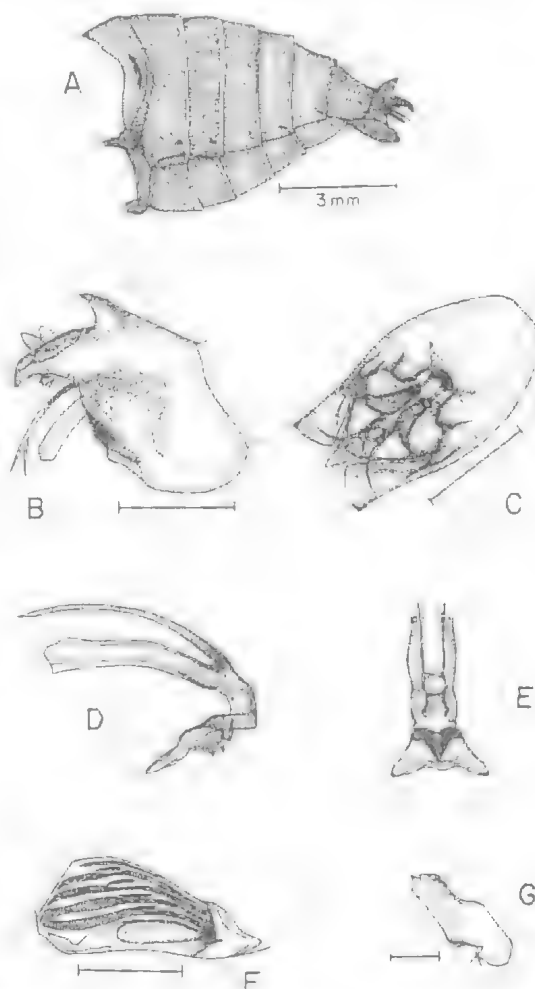


FIG. 50. *Pauropsalta aquilus* sp.n., ♂, from Mon Repos, near Bundaberg, southern Queensland. Symbols A to G, and scales, as in Fig. 2.

Thompson, 1♂, 1♀, Mon Repos, nr Bundaberg, 19.xii.1983, A.E.; 16♂♂, 10♀♀, 20 km N of Monto, 6.xii.1979, M.S. and B.J. Moulds; 2♂♂, 1♀, Mt Moffat N.P., Top Moffat Camp, 13-15.xii.1987, Monteith, Thompson and Yeates (MSM); 14♂♂, 7♀♀, Carnarvon Gorge, 8-12.xii.1985, J.T. Moss and A.E.; 19♂♂, 16♀♀, L. Broadwater, 30 km SW of Dalby, 12.ii.1984, A.E.; 6♂♂, 1♀, Mon Repos, nr Bundaberg, 19.xii.1983, A.E. (AE).

ETYMOLOGY

Derived from Latin, meaning blackish, or dark coloured.

DESCRIPTION

MALE: Head: Black with pale brown markings. Postclypeus shiny black anteriorly with pale brown margins, extending slightly into grooves between transverse ridges; small pale brown dorsal spot on midline; dorsal surface black; short golden-yellow pubescence, especially on dorsal surface. Anteclypeus black with white pubescence. Rostrum brown, becoming darker apically; reaches hind coxae. Antennae brown, paler apically. Mandibular plate and gena black with pale brown intervening suture and conspicuous pale-yellow pubescence. Ocelli deep red. Eyes medium brown. Dorsal surface of head black with wedge-shaped, anterior-pointing, pale brown area in longitudinal suture between ocelli, extending to posterior margin of head; short, scattered yellow-brown pubescence, with conspicuous silver pubescence behind eyes. Vertex lobes pale brown.

Thorax: Pronotum black with central fascia pale brown, somewhat spindle-shaped; short yellow pubescence, especially concentrated between, and in area behind oblique fissures; pronotal collar pale brown.

Mesonotum black with pale brown dorsolateral fasciae, widening medially inwards, and extending to cruciform elevation; wing grooves pale brown; cruciform elevation pale brown; silver-yellow pubescence most conspicuous adjacent to wing grooves, and anteriorly to cruciform elevation.

Legs: Coxae deep brown to black, with longitudinal pale fasciae extending along anterior margins of fore coxae; femora dark brown with prominent broad longitudinal fasciae on fore femora; hind femora grade to pale brown distally; fore and mid tibiae mainly dark brown; hind tibiae pale pink-brown; fore tarsi dark brown while mid and hind tarsi become progressively paler; claws and spines deep brown.

Wings: Fore wing venation brown, tending to become darker distally around apical cells and ambient veins; fore wing costal vein reddish-

brown, darker along anterior margin; pterostigma dark brown to black; infuscation spots on hind wings well developed.

Tymbals: Dorsal ridge extends across dorsal inter-ridge sclerite; two (or three in some specimens) lower ridges joined anteriorly; distinct basal spur.

Opercula: Somewhat elongated, oriented oblique to body axis, with rounded posterior termination; declivous flange along outer margin; anterior region dark brown and somewhat shiny, grading posteriorly to pale yellow-brown colouration with finely rugose and less shiny surface; silvery pubescence especially conspicuous anteriorly.

Abdomen: Tergites black, grading to deep brown adjacent to dorsolateral posterior margins of tergites 4 to 7, and anterior region of tergite 8; tergite margins between tergites 3 to 8 are pale greenish-brown; silver-yellow pubescence sporadically developed, occurring predominantly dorsolaterally. Sternites deep brown to black, with narrow pale yellow-brown margins, most conspicuous between sternites III to V; sternite VIII black, grading to dark brown posteriorly.

Genitalia: Colour deep brown to black; upper lobes form a pair of ascending, blinker-like structures, with acute and inward pointed terminations; lower lobes rounded and not sharply defined; inner lobes raised, somewhat bulbous, but clearly defined; claspers thickly ridged and rounded. Aedeagus with a pair of dorsal pseudoparameres which are tapering and acute, and join endotheca close to gonocoxite ix.

FEMALE: Pigmentation and markings similar to male. Pronotum dominantly pale brown, as is mesonotum. Tergites black with narrow brown dorsolateral zones adjacent to posterior margins of tergites 3 to 6; tergites 7 to 9 black; tergite margins brown, extending along the lateral, lower margins of tergites; silvery pubescence most noticeable dorsolaterally. Sternites black; ovipositor sheath does not extend significantly beyond termination of tergite 9.

MEASUREMENTS: 32♂♂ and 21♀♀. Body length: ♂ 12.4-15.7 (14.58); ♀ 14.0-16.5 (15.31). Fore wing length: ♂ 16.0-18.8 (17.85); ♀ 17.8-20.3 (18.91). Head width: ♂ 4.4-5.1 (4.82); ♀ 4.8-5.3 (5.10).

FIG. 51. Oscillograms of calling songs of *P. equulus* from: A to C, Mon Repos, near Bundaberg (Dec. 1983); D to I, Lake Broadwater, near Dalby (two separate specimens; D to F based on field recording; G to I recorded in captivity; Feb. 1984); J, entrance to Carnarvon Gorge, Carnarvon Ck (Carnarvon National Park; Dec. 1985). Three time scales shown.



TABLE 6. Comparative data on song patterns of *P. aquilus*.

	L. Broadwater (Dalby) Specimen 1 — recorded in captivity	L. Broadwater (Dalby) Specimen 2 — recorded in field	Bargara (Bundaberg) Recorded in captivity	Carnarvon Gorge Recorded in field
Duration of long phrases (sec)	0.60-0.66 (av. 0.63)	0.56-0.66 (av. 0.63)	0.78-0.87 (av. 0.83)	0.64-0.71 (av. 0.68)
Duration between long phrases (sec)	0.36-0.39 (av. 0.38)	0.26-0.32 (av. 0.29)	0.75-0.88 (av. 0.78)	0.32-0.33 (av. 0.32)
Short Phases: (1) Duration of shortest phrases (msec)	18-20 (av. 19.2)	14-15 (av. 14.4)	23-24 (av. 23.5)	15-20 (av. 19.1)
(2) Duration of longer phrases (msec)	44-45 (av. 44.7)	36-37 (av. 36.4)	67-68 (av. 68.0)	35-39 (av. 37.3)
(3) Interval between short and longer phrases (msec)	16-20 (av. 17.7)	18	26-33 (av. 30.5)	19-20 (av. 19.6)
Duration of basic pulse group units (msec)	9.5	7.7	11.4	9.9

Pronotum width: ♂ 4.1-4.9 (4.45); ♀ 4.5-4.9 (4.70).
Abdomen width: ♂ 4.1-4.7 (4.42); ♀ 4.3-4.8 (4.53).

COMMENTS

This species is superficially similar to both *P. corticinus* and *P. fuscata*. Length of rostrum, which extends to hind coxae in *P. aquilus*, is a convenient distinguishing character. In the case of the males, the shape of the upper pygophore lobes (compare Fig. 50B with 16B, and 19B-22B) also enables ready recognition.

DISTRIBUTION

Based on specimen and aural records, *P. aquilus* occurs from near Dalby in southeastern Queensland northwards to near Greenvale, northern Queensland (Fig. 59). Found in open forest, on casuarinas, melaleucas, and eucalypts, invariably in proximity to lakes, swamps, rivers, and even estuaries or the open sea (although not along the coastal edge). The insect sings on the main tree trunks from heights between 1 to 20 metres.

SONG

The following data are based on four sets of songs, two from the Dalby region, one from near Bundaberg, and the fourth from Carnarvon Gorge (Fig. 51). Each basic song pattern shows some variation. The Dalby song patterns exhibit either two short double phrases followed by a long phrase, or one short double phrase, one short

single phrase, followed by the long phrase. The Bundaberg song pattern, however, consists of two double short phrases, followed by a short single phrase, again followed by a long phrase. The Carnarvon song consists of a double short phrase, followed by a single short phrase, followed by the long phrase. In all examples, this basic song is regularly and continuously repeated. In addition, all patterns show an initial rise in amplitude in each set of phrases, the amplitude then remaining at an approximately constant level.

The song structure comprises a compound pulse group unit which varies in length from 7.7 to 11.4 msec (see Table 6). The various long and short phrases are built up from this basic unit, which is either emitted singly, or is combined consecutively in varying numbers. In the Dalby song recorded from a specimen held in captivity, the initial parts of the long phrases are not completely continuous, with small and irregular gaps present, varying between 1 to 15 msec in duration. This is only rarely seen in the other two song patterns (and thus may result from recording the insect in captivity).

The compound pulse group units of the two Dalby specimens when seen on an expanded time scale (Fig. 51F,I) comprise nine distinct pulses (each in reality finer scaled pulse groups, which

FIG. 52. A,B *P. virgulatus* ♀, ♂. C,D *P. siccanus* ♀, ♂. E,F *P. aquilus* ♀, ♂. G,H *P. basalis* ♀, ♂. Each photograph ×2 natural size. Photographs: D.M. Reeves



cannot be further resolved with the available data); pulse repetition frequencies are estimated to be in the range 850-920 (specimen 1) to 1150-1180 Hz (specimen 2). In the example of the Bundaberg song, these 'pulses' cannot so readily be resolved, but they do show a clear tendency to occur in triple groupings within each pulse group unit.

P. BASALIS SPECIES GROUP

This group contains one species, the smallest of the *Pauropsalta*, which is confined to northern Queensland. The male genitalia suggest this to be the most divergent of the species-groups with no clear affinity to any of the other four groups.

Pauropsalta basalis Goding and Froggatt (Figs 52G,H,53,54,55)

Pauropsalta basalis Goding and Froggatt, 1904:625,626;
Distant, 1906b:179; Ashton, 1914:355; Metcalf,
1963:405; Duffels and van der Laan, 1985:300; St
Leger Moss, 1988:30.

Melampsalta basalis (Goding and Froggatt) Burns,
1957:647.

Pauropsalta endeavourensis Distant, 1907a:423;
Metcalf, 1963:407; Duffels and van der Laan,
1985:301. *N.Syn.*

Melampsalta endeavourensis (Distant) Burns, 1957:651.
Cicadetta endeavourensis (Distant) Dugdale,
1972:879,880.

MATERIAL EXAMINED

HOLOTYPE: ♂ of *Pauropsalta basalis*, in ANIC;
Townsville, Queensland, F.P. Dodd, Dec '03; ex MM,
'on permanent loan' to ANIC, bearing red holotype
label.

HOLOTYPE: ♂ of *Pauropsalta endeavourensis* in
BMNH; Endeavour R., Queensland; Distant Coll. 1911-
383; red type label; 9. 28.1.07. W.W.F.

OTHER MATERIAL: 27♂♂ and 6♀♀ from following
localities: QUEENSLAND: Cairns (MV). Sand quarry, Ayr
(QM). Wenlock R., 13°05'S, 142°56'E (UQIC).
Cooktown; Mackay; Proserpine (JM). Laura R. nr
Laura; 10 km S of Woodstock, S of Townsville; York
Downs, 50 km E of Weipa (MSM). Ayr (AE).

DESCRIPTION

MALE: Head: Postclypeus deep brown to black
with broad pale brown margin and conspicuous
pink-brown area dorsally on midline; dorsal
surface black anteriorly and on posterior margins,
elsewhere brown; inconspicuous silvery
pubescence. Anteclypeus black dorsally, grading
ventrally to pale brown. Rostrum pale brown,
becoming paler apically; extends between mid and
hind coxae. Gena and mandibular plate black with
intervening pale brown suture, extending to lateral

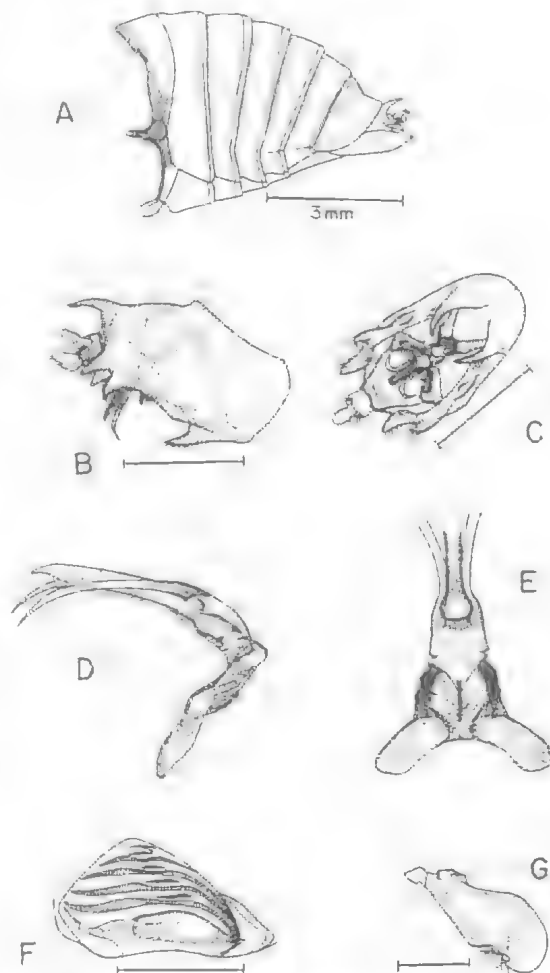


FIG. 53. *Pauropsalta basalis* Goding and Froggatt, ♂, from Ayr, northern Queensland. Symbols A to G, and scales, as in Fig. 2.

clypeal suture; conspicuous silver-yellow
pubescence present. Antennae deep brown. Dorsal
surface of head black with triangular pale brown
area situated on suture extending from median
ocellus to posterior margin of head; yellow-gold
pubescence most conspicuous along anterior
margin, and behind eyes. Ocelli pink. Eyes dark
brown. Vertex lobes pale brown.

Thorax: Pronotum pale to medium brown with
posteriorly tapering pale brown central fascia with
black margins which extend outwards along the
anterior and posterior margins of pronotum;
irregular and broken black markings adjacent to,
and between the oblique fissures, and in areas
behind posterior oblique fissures; pronotal collar
pale brown; silver-yellow pubescence sparsely
present.

Mesonotum brown with broad black lateral fasciae, widening towards anterior margin; short, broad, black dorsolateral fasciae coalescing along anterior margin of mesonotum; median fascia mostly poorly defined, being diffuse anteriorly where it coalesces with the dorsolateral fasciae; cruciform elevation mainly pale pinkish-brown, black anteriorly and laterally; gold-yellow pubescence erratically present, most notably around the cruciform elevation.

Legs: Fore coxae pale brown with dark brown, broad, ventrally tapering fasciae along posterior margins; mid and hind coxae dark brown, becoming paler distally; femora pale brown with dark brown longitudinal fasciae, which are only present on inside margins of fore femora; fore tibiae medium brown, otherwise pale brown; tarsi pale brown, becoming darker distally on fore legs; claws and spines dark brown.

Wings: Fore wings; costal vein pallid, with remaining venation dark brown; pterostigma pale. Venation of hind wings paler; infuscation spots weakly developed; faint infuscation adjacent to plaga.

Tymbals: Dorsal ridge very small, and often difficult to see in older or worn specimens; poorly developed basal spur.

Opercula: Roughly sickle-shaped, obliquely elongated, with broad and rounded posterior termination; colour sandy-brown, darker brown anteriorly; declivous flange along outer margin; posterior margin does not extend beyond sternite II; longitudinally undulate (i.e. parallel to body axis); surface very finely rugose; silver pubescence present, especially around anterior margin.

Abdomen: General shape slightly bulbous. Tergite 2 has irregular, black, anterior pigmentation, otherwise yellow-brown, becoming slightly reddish dorsally; tergites 3 to 8 generally sandy-brown, tending reddish-brown or orange towards posterior margins; tergites 4 to 8 also show median to dorsolateral darker colouration along anterior margins which is more strongly developed towards tergite 8; tergite margins orange-yellow; sparse silver-yellow pubescence, most conspicuous dorsally on tergite 2. Sternite II sandy-brown with darker lateral margins; sternite III to VII sandy-brown becoming more strongly reddish towards sternite VII; sternite margins yellow to orange; sternite VIII rufous.

Genitalia: Colour pale brown; upper and lower lobes ascending, acute, tapering; lower lobe apically hooked; inner lobe ascending, posteriorly inclined, acutely tapering; claspers each with two sets of curved ridge-like processes; aedeagus with

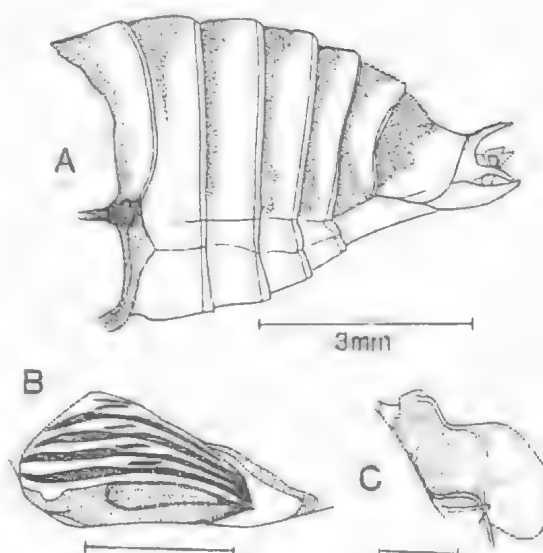


FIG. 54. *Pauropsalta endeavourensis* Distant: Holotype, ♂, BMNH from Endeavour River, Queensland. A: Abdomen. B: Left tymbal. C: Left opercula. Scales 1 mm except where indicated otherwise.

a pair of pseudoparameres attached dorsally, but sloping ventrally across endotheca; pseudoparameres curved, apically tapering.

FEMALE: Similar colouration and markings as in male, being somewhat paler due to less extensive darker areas of pigmentation. Thorax: Pronotum; central fascia lacks black margin. Mesonotum: dorsolateral and median fasciae reduced in extent, and very little black pigmentation around cruciform elevation; remaining colouration pale brown. Venation of fore wings paler than male. Legs paler, with extent of the dark pigmentation on coxae and femora reduced. Abdomen: Tergites pale reddish-brown, with only slight dorso-anterior darkening on tergites 5 to 8; posterior margins to tergites pale greenish-brown; tergite 9 pale sandy brown with dorsolateral dark fasciae extending approximately two-thirds along tergite towards posterior margin; conspicuous short silvery pubescence covers tergites. Sternites II and III pale yellow-brown; sternites IV to VII pale reddish-brown; posterior margins to sternites pale yellowish-brown; ovipositor sheath does not extend significantly beyond termination of tergite 9. General form of abdomen tapering.

MEASUREMENTS: 16♂ and 4♀♀. Body length: ♂ 10.7-12.4 (11.77); ♀ 11.2-12.2 (11.94). Fore wing length: ♂ 13.7-15.2 (14.73); ♀ 13.7-15.2 (14.54). Head width: ♂ 3.7-4.1 (3.91); ♀ 4.0-4.2 (4.08).

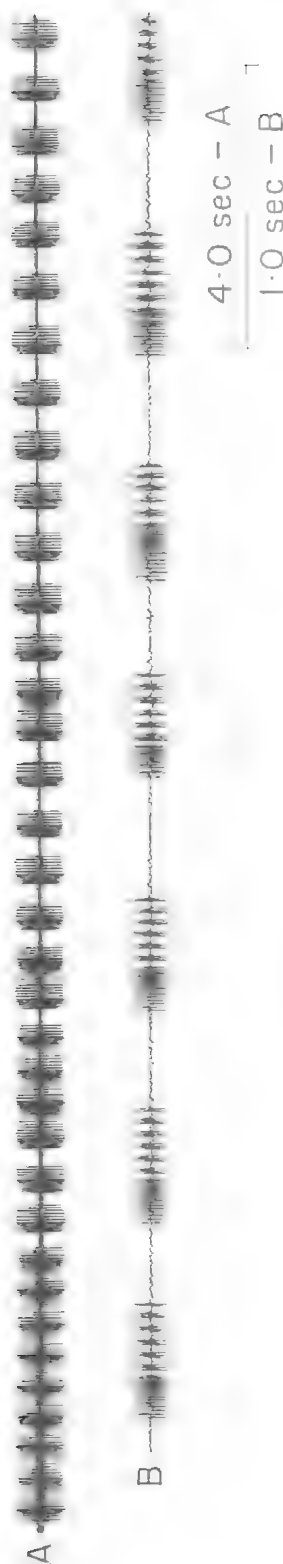


FIG. 55. Oscillograms of calling song of *P. basalis* from Ayr. Two time scales are shown.

Pronotum width: ♂ 3.2-3.6 (3.43); ♂ 3.5-3.6 (3.54). Abdomen width: ♂ 3.6-4.0 (3.76); ♀ 3.4-3.6 (3.52).

COMMENTS

P. endeavourensis Distant appears to be a junior synonym of *P. basalis*. Examination of the type of *P. endeavourensis* (Fig. 54) shows it to have more extensive brown colouration on the tergites than typical *P. basalis* specimens. In terms of morphology, the two holotypes are very similar, and are thus treated as conspecific.

This is the smallest of the *Pauropsalta* species described in this work. Its size and colouration enable it to be easily distinguished.

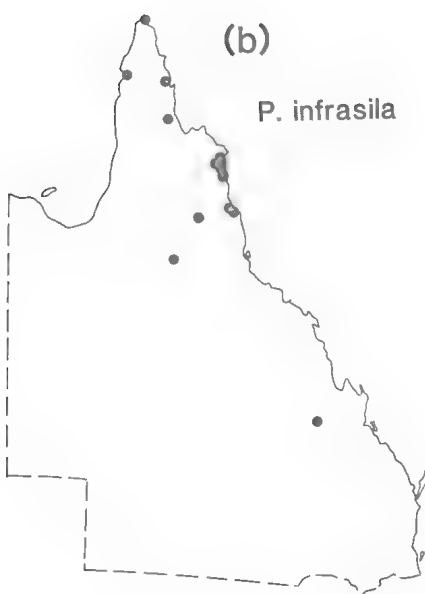
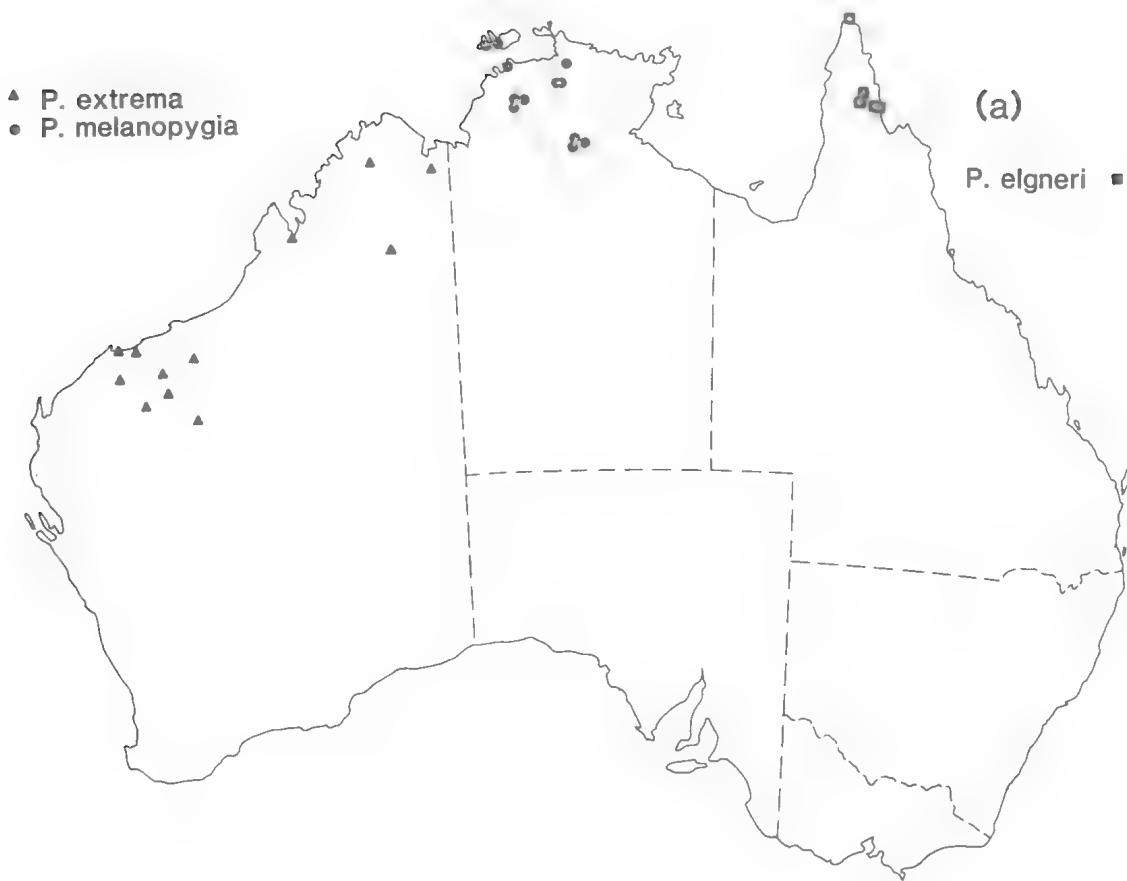
DISTRIBUTION

A northern Queensland species ranging from Mackay northwards along the coastal regions into Cape York Peninsula. Habitat preference is for dry open forest and scrubland, extending to rough grassland. Insects rest and sing on isolated tree trunks, shrubs, and grass. Specimens have been recorded from December to February.

SONG

Consists of series of repeated phrases which may be discrete, or may coalesce (Fig. 55). Each phrase is of approximately 0.30-0.45 sec (av. 0.38) duration, with a repeat interval of 0.20-0.45 sec (av. 0.31) between phrases. The phrases start and finish abruptly, with a small amplitude increase in the mid-phrase. Initially, each phrase shows an increase in pulse repetition rate, followed by a series of discrete pulse groups, usually 5 to 6 in number, each of which can be resolved into triple pulse subgroups; the final pulse group is shortened by comprising only a double pulse subgroup. Each pulse subgroup is itself composed of at least four separate pulses, which is the limit of resolution of the present data. The duration of the pulse groups range between 20-25 msec (triple) to 13-16 msec (double); intervals between pulse groups range between 10-20 msec. The initial portion of each phrase can also be resolved into the same type of pulse subgroups as described above, the increase in pulse repetition frequency occurring simply by an increase in the frequency of production of these small pulse subgroups.

FIG. 56. Distributions of (a) *P. extrema*, *P. melanopygia*; and *P. elgneri*; (b) *P. infrasila*; (c) *P. opacus*. Locality of song recording is shown in (c).



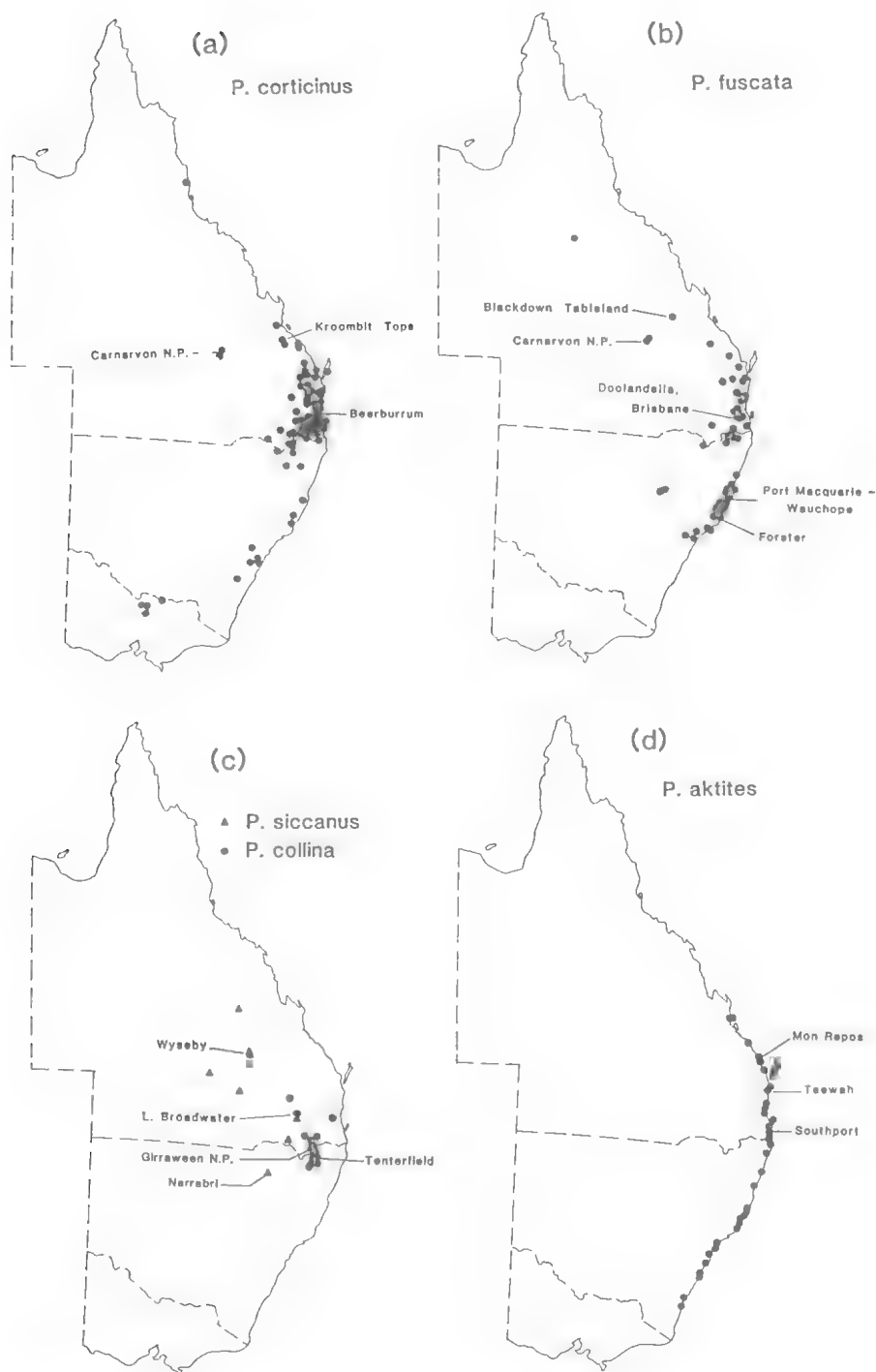


FIG. 57. Distributions of (a) *P. corticinus* (including possible records of *P. corticinus* from Victoria, and an unconfirmed record from northern Queensland); (b) *P. fuscata*; (c) *P. siccanus* and *P. collina*; (d) *P. aktites*. Localities of recordings are shown.

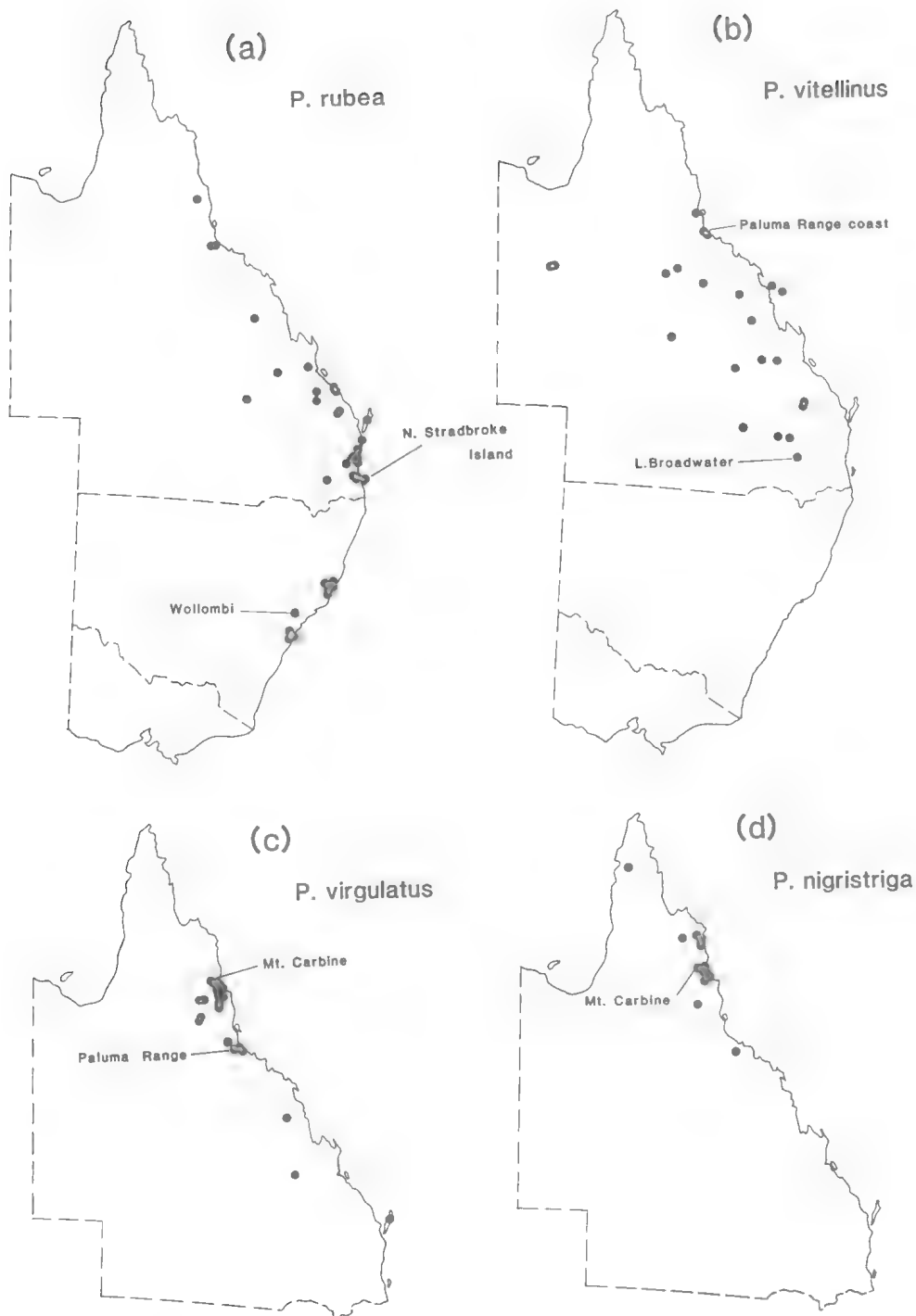


FIG. 58. Distributions of (a) *P. rubea* (including additional aural records of author); (b) *P. vitellinus*; (c) *P. virgulatus*; (d) *P. nigristriga*. Localities of song recordings are shown.

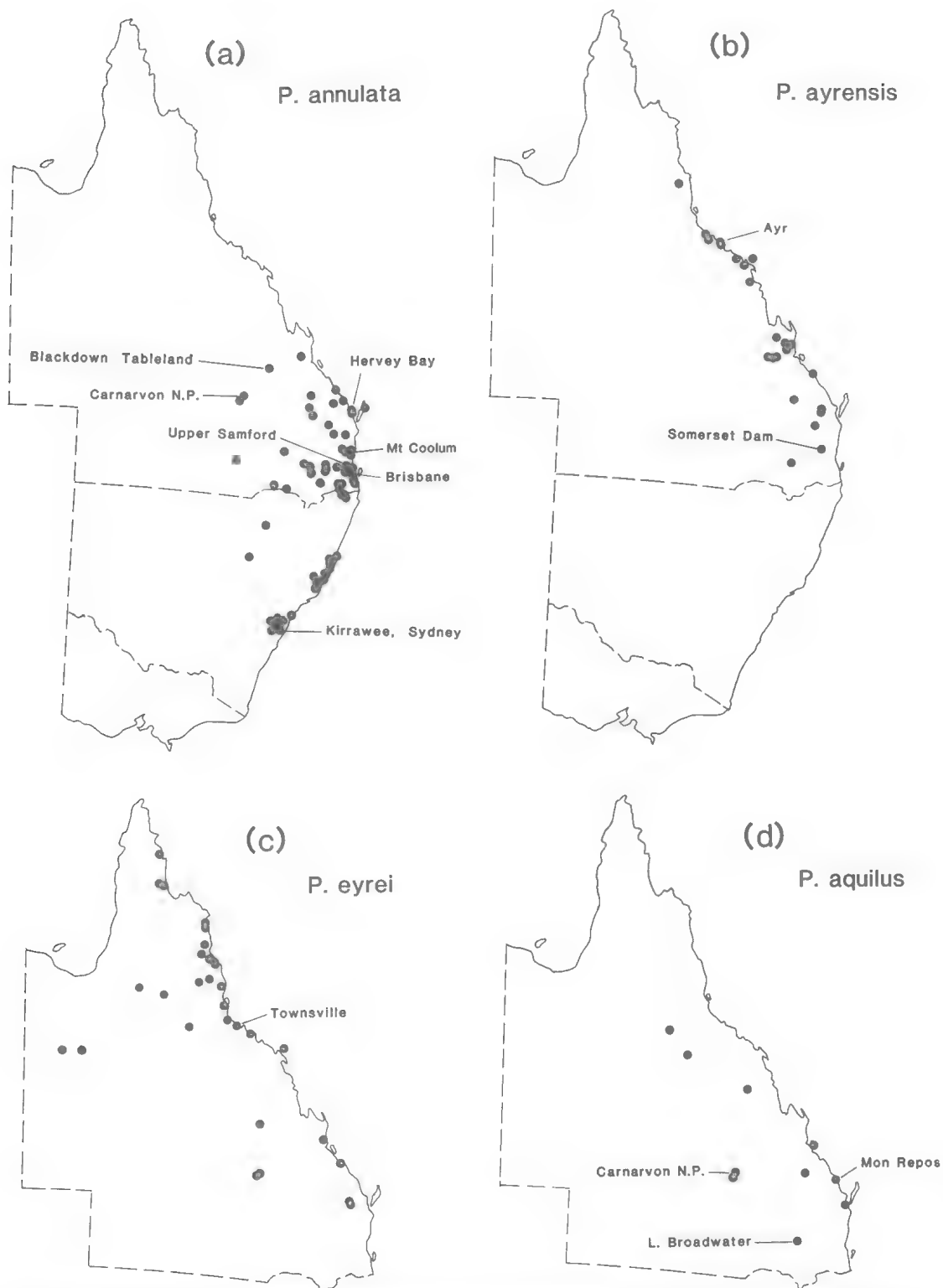


FIG. 59. Distributions of (a) *P. annulata* (including additional aural records of author); (b) *P. ayrensis*; (c) *P. eyrei*; (d) *P. aquilus* (including additional aural records of author). Localities of song recordings are shown.

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INTERTIDAL AND SHALLOW WATER HYDROIDS FROM FIJI. I. ATHECATA TO SERTULARIIDAE

M.J. GIBBONS AND J.S. RYLAND

Gibbons, M.J. and Ryland, J.S. 1989 11 13: Intertidal and shallow water hydroids from Fiji. I. Athecata to Sertulariidae. *Mem. Qd Mus.* 27(2): 377-432. Brisbane. ISSN 0079-8835.

Athecate and thecate hydroids, other than hydrocorallines, were collected intertidally and from shallow water around Viti Levu and its nearby islands, Fiji, 1978-1980. The habitats are described. The collected material, other than Plumulariidae (*sensu lato*), is referred to 40 species, which are described and illustrated. *Clytia edentula* and *Sertularia orthogonalis* are described as species novae. Some of the remaining species were already known to be widely distributed in the Indo-Pacific, but rarely recorded species include *Halecium sibogae* Billard, *Hydrodendron gardineri* (Jarvis) and *Diphasia orientalis* Billard. The history and status of the generic names *Pennaria* Oken, *Pennaria* Goldfuss and *Halocordyle* Allman are discussed in relation to the 'International Code of Zoological Nomenclature'. It is established that, since *Pennaria* Oken was disallowed by the International Commission on Zoological Nomenclature in 1956, *Pennaria* Goldfuss represents a valid introduction and *Halocordyle* becomes its junior subjective synonym. *Sertularia borneensis* Billard is retained and not regarded as conspecific with *S. turbinata* (Lamouroux) but *Thyroscyphus vitiensis* Marktanner-Turneretscher is referred to *T. fruticosus* (Esper).

□ *Hydroida*, taxonomy, Pacific, Fiji, coral reefs, intertidal, shallow water.

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Hydroids were collected from intertidal and shallow-water reefal habitats around Fiji during the period 1978-80. Forty species (excluding Plumulariidae *sensu lato*, which will be described in a second paper) have been recognized. There has been no previous account of Fijian hydroids. Unfortunately, and contrary to the situation for certain temperate areas, there is no monograph covering the Hydroida of the tropical Indo-West Pacific, although a number of expedition reports and accounts of collections from specific regions or island groups have been published, e.g., the voyages of the *Uranie* (Lamouroux, 1824), *Challenger* (Allman, 1883, 1888) and *Siboga* (Billard, 1913, 1925), and covering the Red Sea (Vervoort, 1967; Schmidt, 1972; Hirohito, 1977), western Indian Ocean (Rees and Vervoort, 1987), East Africa (Millard and Bouillon, 1974; Millard, 1975), Madagascar (Billard, 1907; Gravier, 1970), Seychelles (Jarvis, 1922; Millard and Bouillon, 1973, 1975), southern India (Mammen, 1963, 1965, 1967), eastern Indian Ocean (Ritchie, 1910a, b), Great Barrier Reef-Papua New Guinea (Bale, 1884; Kirkpatrick, 1890; Briggs and Gardiner, 1931; Pennycuik, 1959; several papers by Bouillon, e.g. 1984, mostly on medusae); Bonin Islands-Kyushu, Japan (Jäderholm, 1919; Stechow, 1909, 1913; Hirohito, 1969, 1974),

Micronesia (Cooke, 1975), French Polynesia (Vervoort and Vasseur, 1977) and Hawaii (Cooke, 1977). There are also a few papers dealing with Pacific Ocean hydroids generally or with museum holdings that contain specimens from Pacific locations. The papers of Vervoort and Vasseur (1977) and Rees and Vervoort (1987) contain extensive regional bibliographies. The general paucity of information on Melanesia-Micronesia-Polynesia is striking.

The identification of tropical Indo-Pacific hydroids in situ presents enormous problems. It is difficult enough studying them in a European provincial institution that lacks nineteenth century literature and extensive reference collections. We have been largely dependent on both the library and the collections of the British Museum (Natural History). Pennycuik's (1959) paper on Queensland hydroids illustrates the point. Her paper provides a valuable compendium of the species present but is almost useless for identification without a backup library. On the other hand, the good descriptive works of Billard (1913, 1925), Vervoort and Vasseur (1977) and Rees and Vervoort (1987) are either incomplete or describe a fauna patently less diverse than that of Fiji. Our compromise is to suggest the use of Millard's (1975) comprehensive *Hydroida of Southern*

Africa, which is modern, widely available, and fully keyed to families and genera (whether indigenous to South Africa or not), as a base text. We have provided descriptions and illustrations of the Fijian species.

A short background introduction to the coral reefs of Fiji has been given by Ryland (1981), amplified subsequently by sections relating to particular reefs (Ryland, 1982; Ryland, Wigley and Muirhead, 1984; Dilly and Ryland, 1985). Morton and Raj (1980) described some reefs and other intertidal habitats in a University of the South Pacific teaching manual, while Penn (1983) has given an invaluable account of the hydrographic conditions affecting reefs in the vicinity of Suva. A summary of knowledge on Fijian reefs has recently been prepared by Wells (1989).

The Fiji archipelago comprises some 360 islands (Derrick, 1957), the main ones being Viti Levu, Vanua Levu, Taveuni and Kandavu (Fig. 1) disposed from northeast to south in a westerly convex crescent. East of this arc, over the relatively shallow (<3,000 m) Fiji Plateau, lie the many smaller islands of the Lomaiviti and Lau groups extending towards Tonga. Westward of Viti Levu the relative shallows extend as far as the Vanuatu (New Hebrides) island arc. Abyssal depths lie between Fiji and Tuvalu (Ellice Islands) to the north and between Fiji and New Zealand to the south; ocean trenches to the west (Vanuatu) and east (Tonga) delimit the Fiji Plateau. The Fiji islands are wholly tropical (15°30' — 20°30'S) and straddle the 180° meridian. Warm surface water, derived from the South Equatorial Current, flows southwestwards through the group. The hot season maximum sea surface temperature is about 30°C in February-March and the cool season minimum about 24°C in August.

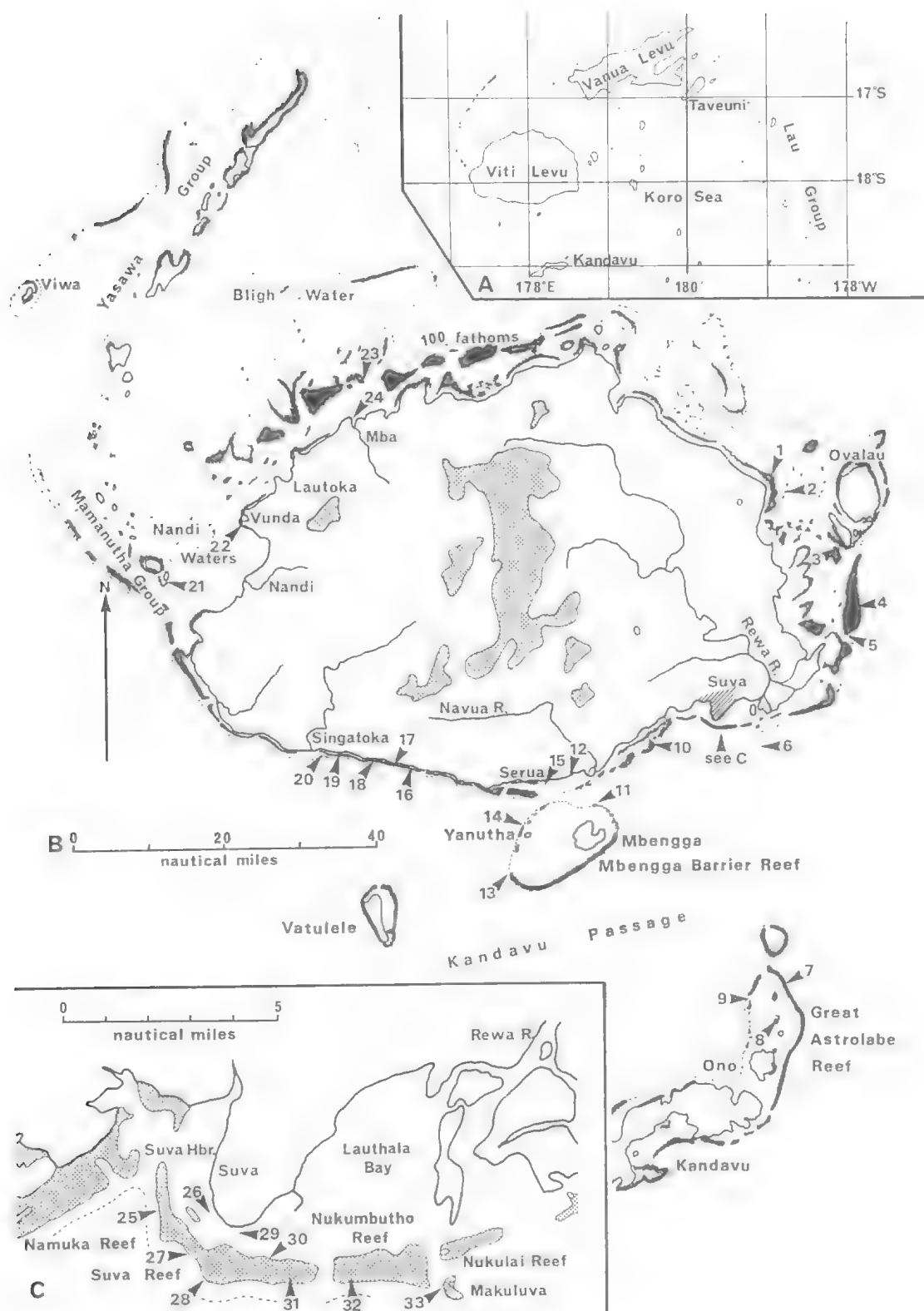
The larger, volcanic islands are surrounded by fringing and/or barrier reefs (depending on the width of their insular shelf), while many of the smaller islands are coral formations (Ladd, 1934). There are no true atolls. The collections have been made mainly around Viti Levu or from the Great Astrolabe Reef northeast of Kandavu. In southwest Viti Levu, in the absence of insular shelf, the shore ('Coral Coast') is lined with fringing reef (Ryland, 1982; Ryland *et al.*, 1984); elsewhere the major reefs lie more or less offshore. The Great Sea Reef, extending for nearly 300 nautical miles (off the area covered by Fig. 1B) delimits the shelf to the north of Vanua Levu and Viti Levu. Northwest of Viti Levu the Great Sea Reef merges into the islands of the Yasawa and Mamanutha chains, from the southern end of

which ribbon reef approaches the shore and continues as the fringing reef of the Coral Coast. The Great Astrolabe Reef is quite separate from this system (Fig. 1B).

Fiji lies in the belt of southeast tradewinds which blow most strongly and persistently from July to December. Thus reefs off Suva and along the south coast are windward reefs, while conditions in Nandi and Bligh Waters are relatively sheltered. Since Viti Levu is high, the southeast is subjected to heavy precipitation (>3,000 mm annually) while the rest of the island is drier and sunnier. The centre and east drain mainly through the tributaries of the Rewa, the outflow from which profoundly affects coastal ecosystems in the Suva area. The Rewa catchment covers 3920 km² of the wettest part of Viti Levu (Derrick, 1957) and has a mean outflow of about $13.5 \times 10^6 \text{ m}^3 \text{ day}^{-1}$ (L. Harris, *pers. comm.*) but reached an estimated peak of $777.6 \times 10^6 \text{ m}^3 \text{ day}^{-1}$ following a cyclone in April, 1980 (Harris, 1980). Smaller rivers include the Navua ($3.9 \times 10^6 \text{ m}^3 \text{ day}^{-1}$) and Singatoka ($3.8 \times 10^6 \text{ m}^3 \text{ day}^{-1}$) in the south and the Mba ($2.3 \times 10^6 \text{ m}^3 \text{ day}^{-1}$) in the northwest. Fresh water from the Navua in the 1980 flood (estimated peak discharge $522.7 \times 10^6 \text{ m}^3 \text{ day}^{-1}$; Harris, 1980) certainly killed all visible coral at the accessible Ndeumba reef, though effects on the less conspicuous animals are unknown to us.

Most collecting was conducted on the reefs near Suva, for which also the best environmental data are available. Neap tides have a mean range of 0.9 m and springs 1.30 m. Tidal cycles occur approximately twice daily but the two tides often differ

FIG. 1. Location map. A: The Fiji archipelago; B: Viti Levu and eastern Kandavu; land over 2000 ft (610 m) stippled, reefs black; C: Suva Harbour and Lauthala Bay; reefs stippled. Locations: 1, Tailevu Point, fringing reef; 2, Nukulevu; 3, Thangilai; 4, Mambualau; 5, Tomberua Pass; 6, deep water (1000 m) site off Makuluva; 7, Great Astrolabe reef, NE of Ndravuni; 8, Yaukuve Levu, fringing reef; 9, Herald Pass; 10, Joske's reef, Namuka; 11, Pratt Reef, north of Mbengga; 12, Fringing reef at E end of Taunovo Bay, Ndeumba; 13, Frigate Pass, Mbengga lagoon; 14, N. end of Yanutha reef; 15, Ngaloa; 16-20, the 'coral coast', fringing reefs: Vorualailai, Tangangge, Namanda, Malevu, Korotongo; 21, Malolo Lailai; 22, Vunda Point fringing reef; 23, Yarawa reef; 24, Sand flats, mouth of Mba river; 25, Suva harbour fore-reef; 26, Nasese; 27, Nasese fore-reef; 28, Suva Point fore-reef; 29, Suva Point sand flats; 30, University back-reef; 31, University reef, seaward fringe; 32, Nukumbutho reef, seaward fringe; 33, Makuluva Pass. (For descriptions of localities see text).



in amplitude. Fortuitously, the lower low tide during springs is diurnal during the cooler months but nocturnal during the hot season; moreover, hot season tides are of smaller amplitude. Penn (1983) has calculated that the reef flat off Suva is emersed by day for 65 out of 88 tides in the three winter months June, July and August but on only 36 occasions in the summer months December, January and February. Further, whereas 30 of the winter emersions in 1979 were associated with predicted lows <0.35 m, in summer 1979–80 no ebbs <0.4 m were predicted. Thus during the hottest, wettest season emersion is usually both infrequent and brief.

Penn's (1983) study also revealed that water flow over the reef is unidirectional and incursive, while outflow from the backreef lagoon proceeds through passes (Fig. 1C). Not only does sessile fauna benefit directly during immersion from the continuous inflow of ocean water over the reef, but the strength and direction of flow prevent any low salinity surface layer of lagoonal water (as whenever the Rewa is in spate) reaching the fore-reef edge where hydroids and other fauna become plentiful. Three visits to the Great Astrolabe Reef leave a strong impression that the same pattern of circulation obtains.

Collections were made at low tide on the fronts of many reefs. Coral boulders on the outer flat of the Suva reefs were turned and examined for hydroids and other sessile fauna (Dilly and Ryland, 1985). Little occurred on boulders away from the reef edge except *Dynamena crisioides*, but large colonies of *Thyrosocyphus fruticosus* grew upright through sand, and a few small species such as *Clytia hemisphaerica* and *Obelia bidentata* occurred on sea grass (*Halodule pinifolia* (Miki) den Hartog) or fine red algae (*Gracilaria* sp.) over backreef sand flats at Suva and Mba. The tops of surge grooves, and the sides of drainage channels, cavities and blow holes, were inspected from above or by snorkelling, the hydroids being picked off or collected from dead coral by hammer and chisel. Such algae as characterized the reef edge (*Turbinaria ornata* (Turner) J. Ag., *Sargassum cristaeifolium* C. Ag. and various tufted, corallineaceous reds) seemed rarely to support hydroids but a restricted patch of a red alga, probably *Laurencia*, at Ndeumba yielded several, mainly sertulariid, species.

On part of the windward Great Astrolabe Reef, sandy surge channels transect the reef and it is possible to swim between irregular banks of coral and other hermatypes. Hydroids were collected from the prolific growths around the bases of large

coral heads. The planar fans of *Gymnangium hians* and *Lytocarpa brevirostris* were clearly orientated across the direction of current flow. By contrast, because of either the relative lack of current or the warming of the shallow water (to 35°C in summer), the analogous niches in the drainage channels on the permanently immersed flat of the Coral Coast fringing reefs (Ryland, 1981, 1982; Ryland *et al.*, 1984) were devoid of hydroids.

A number of collections were made by colleagues using SCUBA in reef passes or on the reef fronts. The larger hydroids in all habitats commonly supported smaller species such as *Hebella scandens*, *H. dyssymetra* and *H. parasitica*. Finally, one deep water species of *Lytocarpa* was obtained fortuitously entangled in a prawn trap.

Hydrocorallines (Milleporidae, Stylasteridae) have been excluded from this paper. However, three species of *Millepora* were known to be present at the time of Boschma's (1948) review of the genus: *M. exaesa* Forsskal, noted by us at Makuluva, *M. platyphylla* Hemprich and Ehrenberg in Ehrenberg, and *M. tenera* Boschma, recorded earlier as *M. tortuosa* by Dana (1848) or *M. tenella* Ortmann. The last two were recorded again from the Suva reefs by Boschma (1950) and can be noted here as being abundant on the windward reefs visited. Three nominal species of *Distlehopora* were listed from Fiji by Boschma (1953), *D. fischeri* Broch, *D. livida* Tonnison-Woods, and *D. violacea* (Pallas). In his later review of the genus, Boschma (1959) synonymized *D. fischeri* with *D. violacea*. *D. livida* was considered a *species dubia* in Boschma's review, and its occurrence in Fiji rests on a single 'tentatively identified' specimen (Boschma, 1959). *D. coccinea* Gray, as defined by Boschma, might be expected from Fiji, since it is known from the Great Barrier Reef, New Caledonia, Samoa and Kiribati (formerly Gilbert Islands) but seems not to have been recorded so far. *D. violacea*, red and straw coloured as well as violet, was seen near the reef edge at many localities. *Stylaster sanguineus* Valenciennes in Milne Edwards and Haime, listed from Fiji by Boschma (1953, 1957), was seen less commonly but still from several localities.

Living hydroids are often of distinctive colour. In the present collections for example, the living hydrocladia of *Macrorhynchia philippina* (which stings painfully) were opaque white, contrasting with the black stem; *Gymnangium eximium* was brilliant yellow; *Thyrosocyphus fruticosus* was often flushed with violet; and *Zygophylax rufa* was

mahogany. Most specimens were preserved in formaldehyde (4% in sea water) or, if associated with required calcareous fauna, in 70% ethanol. Most of the hydroids lost their pigmentation in these preservatives. We are aware of the general lack of descriptions based on living material; for example, nematocysts, tentacle number and attachment of the hydranth to its theca. Attention has been drawn to the general lack of data on tentacle number and descriptions of hydranths elsewhere (Ryland and Warner, 1986; Cornelius, 1987), and future observations should try to redress these omissions.

Material for slide preparation was stained in Grenacher's borax carmine for approximately 1½ hours and differentiated in acid alcohol (0.5% HCl in 70% ethanol) for at least the same time again. Following transfer to 90% ethanol for half an hour, the material was treated with a weak solution of fast green (0.075% in 90% ethanol) for 15 to 90 seconds. It was then dehydrated using absolute alcohol and cleared in xylene. Dirty colonies were dealt with in a number of ways prior to staining: immersion in a 15% solution of glycerol, to attempt mucus dissolution, followed by vigorous washing under a running tap and/or treatment in an ultrasonic cleaner with subsequent bubble removal in a vacuum oven.

The success of the double-staining technique depends largely upon the age of the material and, hence, perisarc thickness: campanulariid and plumulariid hydroids (with the exception of certain thickly polysiphonic aglaophenines) required only 1½ hours in acid alcohol and minimum time in fast green; whereas thicker material, such as *Thyroscyphus fruticosus* needed up to two days in acid alcohol and 90 seconds in fast green. The desired result is a preparation in which the coenosarc and hydranths are stained red and the perisarc is pale blue; to obtain top class results we recommend initial experimentation. Staining of the perisarc has great advantage, particularly facilitating the examination of small structures such as plumulariid nematothecae.

Material has been deposited in the British Museum (Natural History), 4-part register numbers preceded by BM, and the Queensland Museum, number preceded by QM GL.

COLLECTING STATIONS

Collections were made by JSR, or by the colleagues indicated (especially Dr N. Penn) using SCUBA techniques, at 32 stations around Viti Levu and Kandavu (Fig. 1). In addition, a sample

was obtained fortuitously from 1,000 m (Sta. 6) off Suva. Brief descriptive notes on locations follow, the absence of specified dates indicating that several visits were made.

1. Tailevu Point. A silty, low diversity fringing reef some 400–500 m in width lying in the shelter of Ngomma and Ngomma Lailai islands. The part visited extended northwards as far as Nggelekuro village. The reef flat was barren, but holes and channels near the reef edge contained some flourishing coral with, e.g., *Lytocarpia brevirostris* and *Strylaster sanguineus*. Coral, mainly *Acropora humilis* (Dana), and a few other cnidarians, including gorgonians, were present on the reef front at low water of spring tides (LWST).
2. Nukulevu, 27 May 79. A sheltered island 5.5 km SSE of Tailevu Point. *Lytocarpia phyteuma* was collected at 0.5–2 m off the reef just north of Nukulevu.
3. Thangilai, 28 Apr. 79. A cay and reef SW of Ovalau, exposed to the ESE through Moturiki Channel. Abundant alcyonaceans; a few hydroids.
4. Mambualau, 14 May 79, 3 Jul. 80. A small limestone (fossil reef) island, about 0.5 km from the open ocean, in a reef complex which stretches 20 km from Moturiki Channel to Tomberua Passage, approached from the land over 4.5 km of shallows.
5. Tomberua Pass, 3 Jul. 80. Accessible semi-exposed fore-reef east of Kamba Point (the easternmost 'finger' of Viti Levu). The Navuloa mouth of the Rewa opens inside the lee of this point.
6. Samples were obtained from a prawn trap set at a depth of about 1,000 m, seawards of Makuluva cay.
7. Great Astrolabe reef, NE of Ndravuni Island, 23–4 Jun. 78, 23–4 Jul. 78, 11–12 Jul. 80. Oceanic. The reef flat rarely dries, even at LWST. Sandy channels about 1 m wide transect the reef, allowing access to the wavebreak zone. The channel sides supported an abundance of hydroids, such as *Gymnangium eximium*, *G. hians*, *Lytocarpia brevirostris* and *L. phyteuma*. Specimens were also collected in the back-reef area, facing the lagoon.
8. Fringing reef dominated by *Acropora humilis* on the leeward side of Yaukuve Levu, in the Great Astrolabe lagoon, 12 Jul. 80.
9. Herald Pass, leeward from Ndravuni, 24 Jun. 78, at about 27 m (collections by C. Wright).
10. Joske's reef, 18 Sep. 78. Offshore fringing

reef with extensive flat; seaward edge about 2 km from Namuka island. A rich cryptic fauna, including several hydroid species, present under coral boulders to the west of the pass.

11. Pratt reef, north of Mbengga island, 3 Nov. 79. Site was NE edge of Pratt reef, exposed to refracted swells and seas, with strong tidal flow. Coral outcrops ('bommies') rise from the sea bed at about 12 m depth to within 1 m of the surface. Gorgonians noted as abundant in water as shallow as 2 m. Hydroids collected from the bommie, 1–5 m (N. Penn).
12. Ndeumba. A small, sheltered reef fringing a platform, apparently of raised reef resting on conglomerate, around a promontory at the west end of Taunovo Bay, 8 km west of the Ndeumba mouth of the Navua river. The reef front drops to sand at 1.5–3 m. The water was almost invariably turbid. The reef front was notable for the abundance of *Macrorhynchia philippina*, obtained nowhere else, and for small crevasses at about LWST which were a rich site for hydroids such as *Zygophylax rufa* and the small form of *Gymnangium eximium*. The eastern end of the reef, where it merges with the beach of another sandy bay, was exposed to continuous wave chop, and was carpeted with red algae (? *Laurencia*), with some *Sargassum* sp. Numerous hydroids, particularly *Clytia hemisphaerica* and *C. edentula* sp. n., *Sertularia borneensis*, *S. hupferi*, *S. turbinata*, and *Monothecha obliqua*, were collected on these algae.
The site was last visited on 1 Jun. 80, two months after the devastating rainfall of cyclone 'Wally' (detailed by Harris, 1980). Some account of the cyclone, and of the effects of the consequent severe flooding on south coast reef biota, have been given by Ryland *et al.* (1984). The Navua river catchment suffered severe flooding and damage, the peak river discharge being estimated at 6050 m³ s⁻¹ (normally 45). Extensive landslides produced a huge sediment load and a 0.6 m deposit on the flood plain around Navua town (Harris, 1980). The scleractinian corals, *Millepora*, and alcyonaceans formerly prevalent on the Ndeumba reef, were all dead. Extensive deposits of red soil were still present on the foreshore of nearby Ngaloa on 16 Aug. 1980.
13. Frigate Pass, the first break from the leeward end of Mbengga barrier reef, 2 Nov. 79. Collections were made on the western, dissected side of a 'bommie' rising from the sea bed at about 18–25 m depth to within about 3 m of the surface. Luxuriant coral growth, antipatharians, and other sessile forms. Hydroids from 3–10 m (N. Penn).
14. Yanutha reef, the northerly of the two reefs seaward of Yanutha island, 7 Oct. 79. A dive was made at the northern tip of Yanutha reef on 2–3 m wide crevasses between 'bommies' rising from the sea bed at about 25 m depth to within 1 m of surface; strong tidal flow but relatively sheltered from wave action. Gorgonians up to 2 m across growing vertically at right angles to the 'bommie' sides; 0–20 m (N. Penn).
15. Ngaloa. 15 Jun. 79. Hydroids were collected just sublittorally of the landward side of a reef some 100 m offshore (N. Penn).
- 16–20. 'Coral Coast' fringing reefs. Sites visited correspond to passes associated with discharge from creeks: (16) Minora Ck, Votualailai, W side; (17) Tangange Ck, E side; (18) Undu Ck, Namanda, W side; (19) Mbulu Ck, Malevu, W side; (20) Korotongo Ck, W side. Some account of the habitats and biota of these reefs has already been given (Ryland, 1982; Ryland *et al.*, 1984). The levees flanking the passes provide quick access to the reef front, 0.6–1.0 km offshore. Collections were made from various zones of the reef, mostly near the pass. The accessible habitats on these reefs seemed to support few hydroids (*cf.* stations 7 and 12).
21. Malolo Lailai; lagoon floor, west side of island (A. Muirhead).
22. Vunda Point fringing reef, 12 Jul. 79, 3 Sep. 79, 17 May 80. A barren, sediment-covered flat up to 700 m across, dominated by variously coloured clones of a species of *Zoanthus*. *Dynamena crisioides* seemed to be the only hydroid present. The surrounding water was very turbid and the reef edge too brittle successfully to approach from the land.
Navini island, a patch reef and cay in Nandi Waters, 14.5 km W of Vunda, was also visited. Despite the prolific sublittoral coral fauna (Ryland, 1982), no hydroids were obtained.
23. The SE corner of Yarawa reef, 17 km N of Mba town and 6 km NNE of the low water mouth of the Mba river. The reef is normally well clear of turbid water, though this can reach the reef at times of flood. The boundary between lagoon and clear ocean water was

noted to be at the seaward end of the Mba and other passages during a dry spell in August 1978. Salinity in the vicinity of Yarawa reef was 33‰. This was the only offshore platform reef in the lee of Viti Levu that was visited, and it was markedly different from the other sites. Extensive notes were taken describing the southeastern corner, near the beacon, during a visit on 8–9 Aug. 78 (Institute of Marine Resources, University of the South Pacific, internal report, 1978) and on 30 Jul. 80.

The main reef area, the flat, stayed covered with 12–18 cm water at low tide. Leaving the flat, the reef surface first ascended slightly (the rubble zone), declined into a discontinuous shallow moat, ascended again (the summit), and sloped for some 30 m into the sea, where the reef edge was jagged and the front dropped to chart depths of 27–40 m. The seaward slope, superficially appearing solid, in fact contained deep channels, inlets, caves, and blowholes, in which were plate-like growths of *Montipora* sp. and *Echinopora lamellosa* (Esper). Coral cover varied from 25 to 75%, and was richest at the very edge; coral-free areas were dominated by crustose coralline algae. In parts the dominant coral was *Acropora formosa* (Dana), with *A. humilis*, various faviids, and *Lobophytum*. Notable absentees were *Millepora*, *Distichopora*, *Tubipora*, *Pocillopora* spp. other than *P. damicornis* (L.), zoanthids (except occasional *Palythoa*), *Xenia*, coralline turf, and macroalgae, seen elsewhere but presumably an assemblage characteristic of windward reefs.

The summit was characterized by an efflux of water draining from the flat. Where there were pools coral flourished; elsewhere the cover was only 10–15%, mainly *Acropora humilis*. Scattered small heads of *Palythoa*, *Lobophytum* and *Sinularia* were present. The summit pools merged into a narrow moat where, in places, water lay up to 1 m deep. Inshore of the moat, the rubble zone consisted of *Acropora* shingle and dead, inverted *Acropora* heads. This zone was dry at low tide, but under the boulders and amongst the shingle lived a rich cryptofauna. Coral species included *Montipora digitata* Dana, *A. formosa*, *P. damicornis*, *Porites* and *Goniastrea*, with holothurians, varied infaunal crustaceans, and an under-boulder sessile fauna of bryozoans, sponges, ascidians, the for-

miniferan *Homotrema rubrum* (Lamarck), and hydroids, together with a notably rich gastropod assemblage.

The reef-flat 'lagoon' contained areas dominated by the coralline alga *Amphirao*, flat, wide microatolls of *Porites* (again in contrast to the windward reefs), *Fungia*, *Pocillopora damicornis*, *Pavona divaricata* Lamarck and *Pavona decussata* (Dana). Clumps of algae such as *Halimeda* spp., *Padina gymnospora* (Kuetz.) Vickers, *Turbinnaria ornata* (Turner) J. Ag., a loose *Sargassum* (the last two pilose with *Jantia*), and the sea grass *Halophila*, probably *H. minor* (Zoll) den Hartog (see Penn, 1983), *Dynamena crisioides* and the ascidian *Lissoclinum bistratum* (Sluiter) were abundant on the rubble. Further into the 'lagoon' the patches of sand increased in area, and *L. bistratum* was restricted to the clumps of *Halimeda* (most of the reef-flat ascidians characteristic of windward reefs (Ryland *et al.*, 1984) being absent).

24. Mba flats, 8–9 Aug. 78. An extensive sand fan had accumulated at the mouth of the Mba river, its level being too low for colonization by the mangrove *Rhizophora stylosa* Griff. In parts the sand was coarse (diameter mainly >0.4 mm), elsewhere silt occurred, with fine sand dominant (particles in the range 0.1–0.4 mm). Two sea grasses were present, *Halophila* ?*minor* and *Halodule pinifolia*, together with the green alga *Enteromorpha*, the red alga *Gracilaria secundata* Harvey, and seedlings of *R. stylosa*. The *Gracilaria* generally supported a felt of filamentous Ectocarpaceae admixed with two campanulariid hydroids *Clytia hemisphaerica* and *Obelia bidentata*. During the Institute of Marine Resources visit, 8–9 Aug. 78, salinity in the channel through the flats was recorded as 26‰ (LW) and 32‰ (HW). These might be expected to drop dramatically at times of flood.
25. Suva barrier reef, Levu Passage, near the harbour entrance, the 'Fish Patch'. The 'Fish Patch' is a ledge, some 150 x 80 m, at a depth of 10–12 m, slightly seaward of the reef front, notable for the abundance of the fungiid *Zooplus echinatus* Dana. It is a generally sheltered locality subject only to weak tidal currents. Hydroids were collected from the 'Fish Patch', 3 Jun. 80, and down to 30 m on its seaward wall, this dropping vertically for over 100 m, 21 Nov. 79, 3 Jun. 80 (N. Penn).
26. Nesese, Suva, 7 Aug. 79 and 31 May 80.

Sheltered foreshore with reef of *Goniopora* and *Porites* reached by wading from Nesese (west of the creek). Two species of *Sargassum* (especially 'sp. 2' of Morton and Raj, 1980) with bryozoans and compound ascidians; *Dynamena crisioides* was the only hydroid.

27. Suva barrier reef, SW bight, 19 Feb. 80. Fore-reef slope with well developed spur and groove formation, 0–9 m; slope rubble covered, 9–20 m; drop-off at 20 m. Exposed (through less so than Sta. 28). Hydroids collected at 3–9 m (N. Penn).
28. Suva barrier reef, southernmost point (offshore from Suva Point), 3 Apr. 79. Extremely exposed, with classic spur and groove structure. Hydroids from 3–12 m (N. Penn).
29. Extensive muddy-sand flats off Veiufo, Suva Point, bounded at LWST by three navigational beacons, described by Morton and Raj (1980, Pt. VI). A sparse covering of the sea grasses *Halophila ?minor* and *Halodule pinifolia*, together with the algae *Halimeda macroloba* Dcne. and *Gracilaria secundata*, offered the only substrata for hydroids.
30. Back of Suva barrier reef, opposite University Campus. Shoal at 4–6 m marked with black navigational beacon.
31. Wave-break zone and fore-reef flat of Suva barrier reef, opposite University Campus. This site, and the fauna associated with boulders, has been described by Dilly and Ryland (1985).
32. Site similar to 31 but on Nukumbutho reef.
33. Nukulau (Makuluva) Pass. Very exposed SW front of Makuluva reef. Surge channels to depth of 12 m, rubble slope to 25 m. Luxuriant reef, despite proximity to Rewa river mouths. Dive 0–23 m, 2 May 80 (N. Penn).

SYSTEMATIC ACCOUNT

Order ATHECATA

Family BOUGAINVILLIIDAE

Incertae sedis

DESCRIPTION

Stem monosiphonic, colony reaching an observed height of 8 mm. Branches short, alternate, in many planes. Hydranths terminal, at the ends of both stem and branches. Perisarc extending over column of hydranth and terminating below the tentacles as a pseudohydrotheca: annulated at the base. Hydranth of varied shape,

with conical hypostome. Tentacles filiform, 14–18, concentrated at or near the oral end, in 1–3 close whorls. Gonophores not observed.

The absence of gonophores and the variable number of tentacular whorls make the assignment of this material to genus impossible.

OCCURRENCE IN FIJI

On coral boulder, crest of Suva barrier reef; 27 Apr. 79.

Family CLAVIDAE

Tubiclava Allman, 1863

Tubiclava sp. (Fig. 2)

DESCRIPTION

Colony comprising solitary hydranths united by a common hydrorhiza; maximum height 2.5 mm. Hydrorhiza covered by firm perisarc extending 0.6–1.1 mm to base of pedicel, leaving most of the latter and all the hydranth naked; difficult to differentiate pedicel from hydranth. Hydranth non-retractile, with conical hypostome and variable number of irregularly arranged filiform tentacles, sometimes distributed in weak whorls. Gonophores not observed.

OCCURRENCE IN FIJI

Under coral boulder, Nukumbutho reef flat; 11 Jun. 80 (QM GL10173).

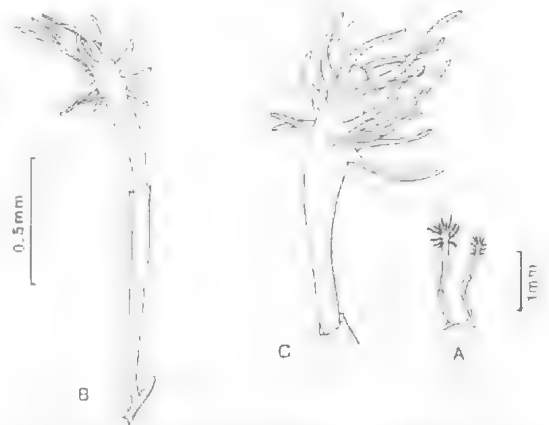


FIG. 2. *Tubiclava* sp., Nukumbutho reef (QM GL10173)

Family EUDENDRIIDAE

Eudendrium Ehrenberg, 1834

Eudendrium sp. (Fig. 3)

DESCRIPTION

Colonies up to 30 mm in height. Stem monosi-

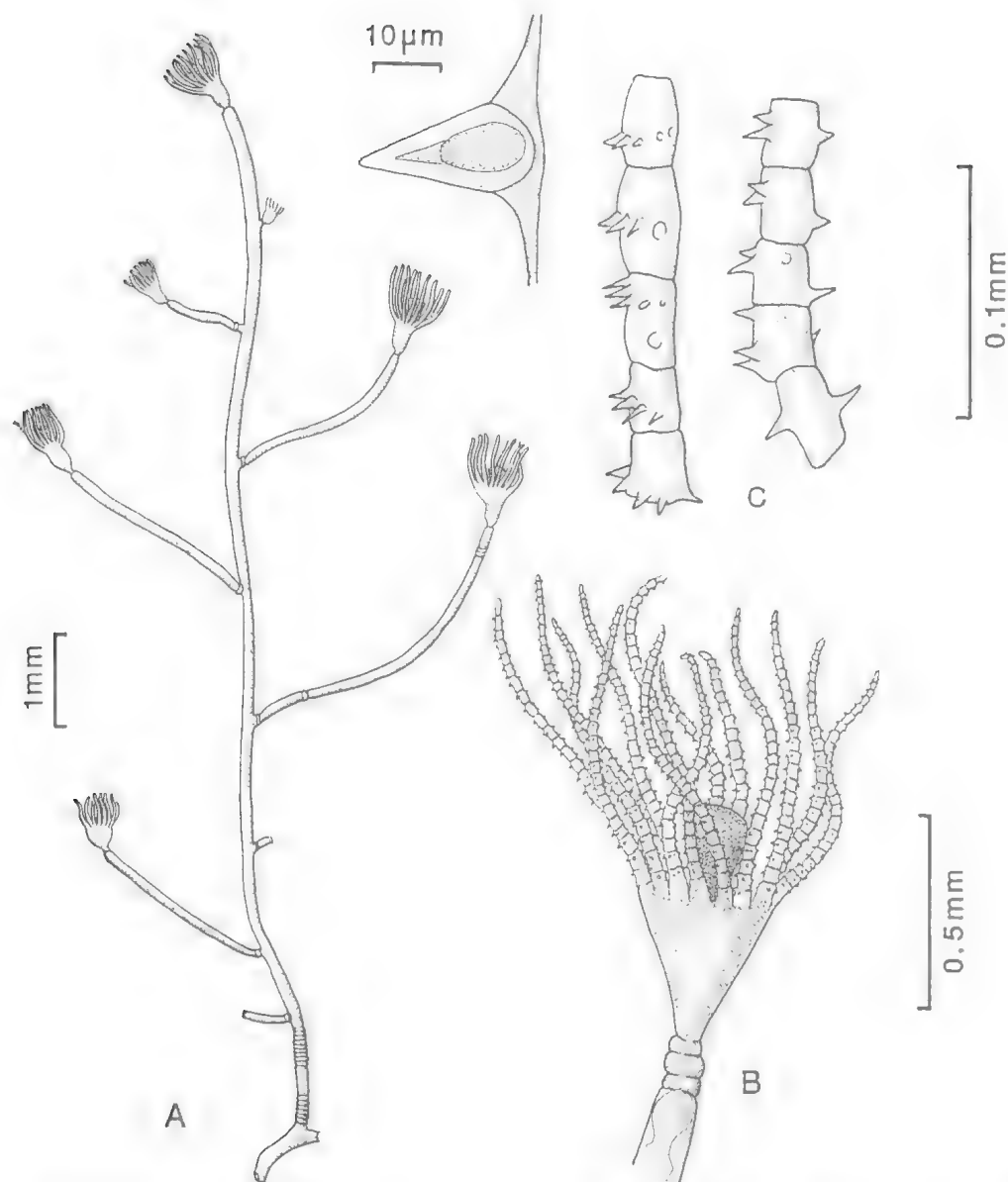


FIG. 3. *Eudendrium* sp. A, colony; B, hydranth; C, parts of tentacles; D, nematocyst. Votualailai (QM GL10174)

phonic, branching alternately; with 1-2 annulations at the bases of branches and irregularly along their length; perisarc tubes otherwise smooth. Hydranth with 16-24 long filiform tentacles; these with regular transverse nematocyst batteries and numerous, irregularly scattered short cnidocils. Gonophores absent.

OCCURRENCE IN FIJI

On boulder, crest of Suva barrier reef, 27 Apr.

79; Sta. 27, N. Penn coll., 19 Feb. 80; Votualailai, 9 Aug. 79 (QM GL10174).

Family CORYNIDAE
Coryne Gaertner in Pallas, 1774
Coryne sp. (Fig. 4)

DESCRIPTION

Stem monosiphonic; colony reaching 9 mm.

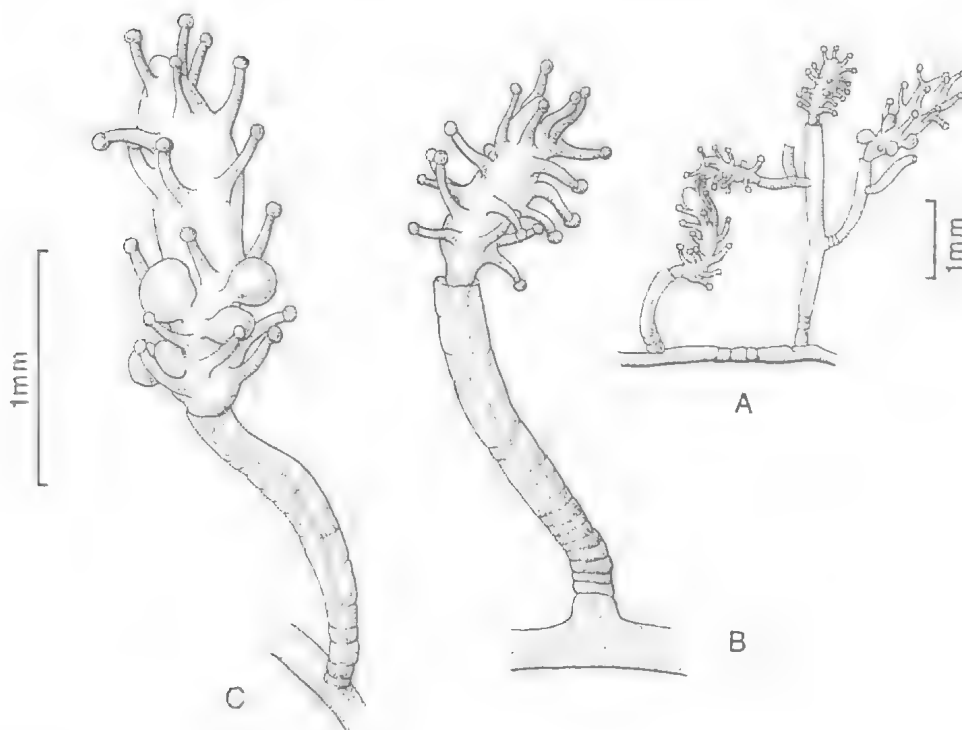


FIG. 4. *Coryne* sp., Yarawa reef (QM GL10175)

Hydranths arising from hydrorhiza or hydrocaulus. Branching irregularly alternate. Perisarc firm, extending to just below hydranth and annulated at the base of stem and branches; also indistinctly throughout, giving the impression of corrugation. Hydranth spindle-shaped with conical hypostome; tentacles 16–24 short, all capitate, in 4–5 indistinct whorls. Gonophores interspersed with the basal tentacles, each in the form of rounded sporosacs, often with a nipple-like protuberance at the distal end.

OCCURRENCE IN FIJI

One record, under coral boulder, Yarawa reef; intertidal; 8 Nov. 78 (BM 1984.5.17.4; QM GL10175).

Family PENNARIIDAE *Pennaria* Goldfuss, 1820

The genus *Pennaria* was first introduced by Oken (1815: 93) to accommodate *P. lendigera*, 'Nisskoralline' (a new introduction for *Sertularia lendigera* Linnaeus, 1758: 812, a bryozoan now placed in *Amathia*). Also listed were seven other

species then known as *Sertularia*, all thecate hydroids. *Sertularia Pennaria* Linnaeus, 1758 (p. 813) was not among them.

The International Commission on Zoological Nomenclature (ICZN) ruled, in Opinion 417 (1956), that no name published by Oken in his 'Lehrbuch' (1815) acquired the status of availability in zoological nomenclature by virtue of having been so published. *Pennaria* Oken, 1815, thus has no status, no validity in zoological nomenclature, and no influence on any subsequent use of the name. We are grateful to Dr R.V. Melville (*in litt.*, 11 Mar. 1985) for confirming that the view which we are advancing here is nomenclaturally correct; the significance of the ICZN ruling seems to have been misunderstood by several workers, most recently by Calder (1988).

Sertularia Pennaria Linnaeus, 1758, from examination of its type at the Linnean Society of London, is a large aglaopheniine hydroid collected by G.W. Steller, probably from Kamchatka and not, as Linnaeus indicated, from the Indian Ocean (Cornelius 1979: 309, Note 14). Cavolini (1785, p.134; Pl. 5), evidently mistaking an athecate hydroid known to himself in Italy for the Linnean species, described as 'la Sertolara Pennara' (*Ser-*

tularia Pennaria in Sprengel's 1813 translation) the Mediterranean species now well-known as *Pennaria disticha* Goldfuss, 1820 (e.g., Brinkmann-Voss, 1970).

Pennaria Goldfuss, 1820: 89, was established to accommodate two species, *P. disticha* Goldfuss, 1820 ('*Sertolara Pennara*' of Cavolini) and *P. parastileia* Goldfuss, 1820 ('*Sertolara parassita*' of Cavolini). The genus was properly introduced and, in view of the ICZN ruling (Opinion 417, 1956), is a valid zoological name; it did not, and does not, require validation under the ICZN Plenary Powers (cf. the situation for *Halecium* Oken, p. 390). It has no connexion with Oken's *Pennaria*, based on *Amathia lendigera*, or with Linnaeus' *Sertularia Pennaria*. Hirohito (1977) stated that *Pennaria* Goldfuss was preoccupied by *Pennaria* Blainville, 1818, a genus of Polychaeta. Hirohito gave no reference to back up this statement; which appears to be based on the entries under 'Pennaire' and 'Pheruse' (Blainville, 1818, pp. 158, 520-21 respectively), in which Blainville proposed 'Pennaire' to replace *Pherusa* Ocken [sic], a genus of Polychaeta, preoccupied by *Pherusa* Lamouroux, a genus of Bryozoa. Blainville's use of Pennaire does not constitute a valid introduction, since the latinized form *Pennaria* was not used.

Allman (1872: 368) maintained *Pennaria* for *P. disticha* Goldfuss but introduced *Halocordyle* for the similar American species *Globiceps tiarella* Ayers, 1854: 193, on the grounds that the capitate tentacles were in verticils rather than being irregularly dispersed over the hydranth. A more usual view (Millard, 1975) is to regard *P. disticha* and *G. tiarella* as congeneric, or even conspecific (Garcia-Corrales and Aguirre, 1985; Calder, 1988), and hence, until recently, usually placed in *Pennaria*. The two nominal species are reportedly widely distributed in the tropics and subtropics and *Pennaria* has become a very familiar name. More recently, some authors (e.g., Millard, 1975; Hirohito, 1977; Watson, 1982; Calder, 1988), following Stechow (1922) rather than the more recent ICZN ruling, have adopted *Halocordyle*. Others (e.g., Brinkmann-Voss, 1970) have not. However, it seems clear from the foregoing discussion that, since *Pennaria* Oken must be set aside, *Halocordyle* becomes a subjective synonym of *Pennaria* Goldfuss, and Stechow's argument is superseded.

Furthermore, *Halocordyle* Allman, 1872, is the junior subjective synonym of *Eucoryne* Leidy, 1855 (which Allman mistakenly assumed to be preoccupied by *Eucorynus* Schoenherr, a genus of

Coleoptera). To maintain *Halocordyle* as the name for the present genus would thus require the International Commission on Zoological Nomenclature to set aside not only *Eucoryne* Leidy, which might present no problem, but *Pennaria* Goldfuss as well.

Which generic name would best promote nomenclatural stability? Suppressing either *Pennaria* or *Halocordyle* will inevitably cause confusion (though this exists already: Dunn's, 1982, classification of Cnidaria retains both). For *Halocordyle* it can be argued that most specialist works on Hydroida since 1975 and a few more popular books have used it; *Pennaria*, however, is the name still used in the more general field guides (e.g., Gosner, 1979) and zoology textbooks, including the various editions of Barnes' influential *Invertebrate Zoology* (5th ed. 1987). In the circumstances, the best solution to an unsatisfactory state of affairs seems to be to follow the Code.

According to Bedot (1901: 459) *P. disticha* is the type species of *Pennaria* Goldfuss, but we have not searched for an earlier designation.

Pennaria disticha Goldfuss, 1820 (Fig. 5)

Pennaria disticha Goldfuss, 1820: 89

Pennaria australis Bale, 1884: 45

Halocordyle disticha (Goldfuss, 1820): Millard 1975: 41

DESCRIPTION

Stems upright, monosiphonic but with a firm perisarc, reaching 65 mm; pinnate; main stem divided by variably annulated nodes into regular internodes, each bearing a distal hydrocladial apophysis. Hydrocladia alternate, in plane of stem, of variable length, those in the middle tending to be longest; multi-annulated at base and divided by annulated nodes into internodes, each with a distal ramule on its upper surface. Ramules unsegmented but annulated for most of their length.

Hydranths borne at the ends of stems, hydrocladia and ramules; with a basal whorl of 10-15 filiform tentacles, longer than the hydranth body, and 10-22 short capitate distal tentacles irregularly scattered or arranged in a loose verticil. Hypostome conical.

Gonophores borne between the two sets of tentacles, small, pear-shaped, shortly pedicellate.

VARIATIONS

Length of ramules on hydrocladia decreases distad. Length of filiform tentacles variable in

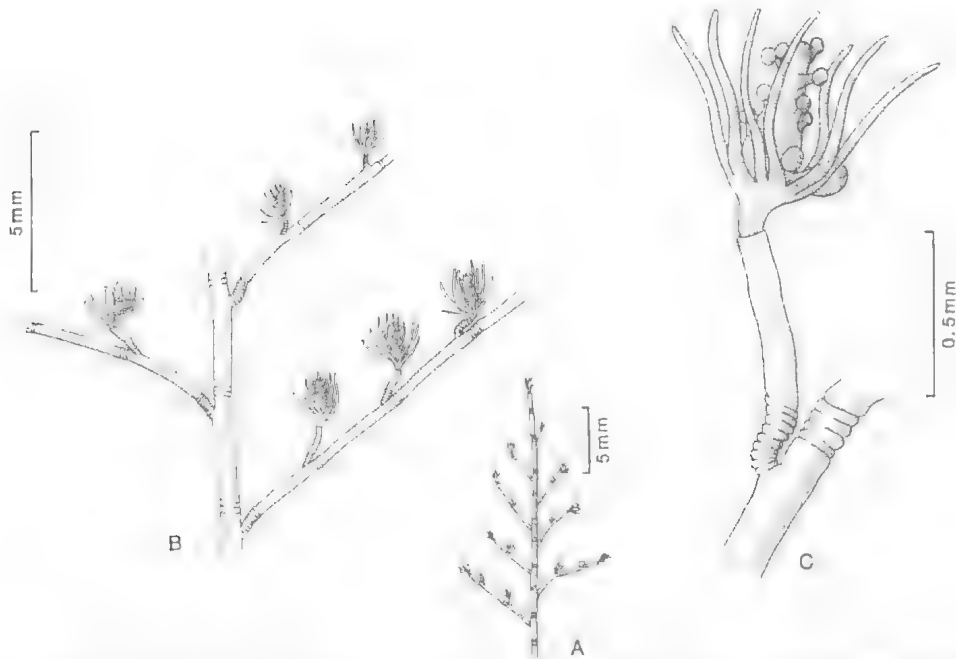


FIG. 5. *Pennaria disticha* (A, habit sketch; B, portion of stem with hydranths; C, hydranth (QM GL10176) Joske's reef

preservation but always greater than the height of the hydranth. The amount of annulation on the stem, hydrocladia and ramules is now recognized as being highly variable, and Millard (1975: 41) consequently referred *Pennaria australis* Bale, 1884, to *P. disticha*.

OCCURRENCE IN FIJI

Always present in the wavebreak zone of the reefs near Suva (Nukumbutho, Suva (BM 1984.5.17.1, 2), Joske's (QM GL10176)) attached to boulders, in clefts or growing in the algal turf. Gonophores recorded April and June-September. Also Christmas I. (Line Is), 18 Feb. 79.

WORLD DISTRIBUTION

Circumglobal in tropical to warm-temperate waters, with the nominal species *P. tiarella* (Ayers) included in the synonymy of this species (García-Corrales and Aguirre, 1985; Calder, 1988) providing many of the New World records.

***Pennaria wilsoni* Bale, 1913
(Fig. 6)**

Halocordyle australis Bale, 1894: 94

Pennaria wilsoni Bale, 1913: 116

Halocordyle wilsoni (Bale, 1913); Pennycuik 1959: 160

DESCRIPTION

Stem upright, monosiphonic but with firm perisarc, reaching 35 mm; pinnate; stem divided by nodes into regular internodes, each bearing a hydrocladial apophysis at the distal end and a variable number of annulations at the nodes. Hydrocladia alternate, of variable length, in plane of stem, at about 45° to the axis; annulated at the base, non-segmented and smooth from base to apex, sometimes with a few terminal annulations.

Hydranths borne at the ends of stem and hydrocladia; basal whorl of 7-8 filiform tentacles shorter than hydranth body, thick and slightly clavate in preserved material, usually orthogonal to hydranth; oral whorl of 5-6 short capitate tentacles distally, tightly packed and directed upwards. Hypostome conical; length and shape of hydranth body variable in preserved material.

Gonophores borne on the hydranth body between the basal and oral tentacles, whorls large and spherical.

REMARKS

This material resembles closely the description of Pennycuik (1959) but less so those of Bale (1894)

and Watson (1982). The two last describe *P. wilsoni* as having several, alternately arranged hydranths per hydrocladium rather than one terminal hydranth. The single whorl of oral capitate tentacles is a specific character agreed by all authors. In the Fijian material the hydrocladia branch at about 43° ($31\text{--}55^\circ$) to the stem axis, whereas in *P. disticha* the mean angle is 50° ($38\text{--}62^\circ$).

OCCURRENCE IN FIJI

Reef-edge algal turf, Suva barrier reef (BM 1984.5.17.3; QM GL10177/8/9). It seems surprising to find this fragile looking hydroid in such a high energy environment.

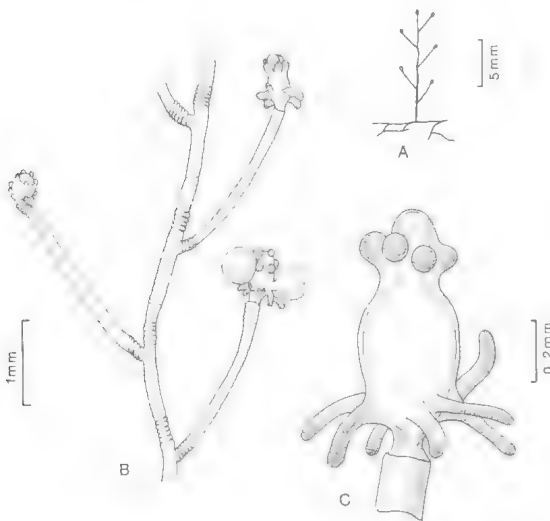


FIG. 6. *Pennaria wilsoni*. A, habit sketch; B, portion of stem with hydranths and gonophores; C, hydranth. Suva Barrier reef (QM GL10177).

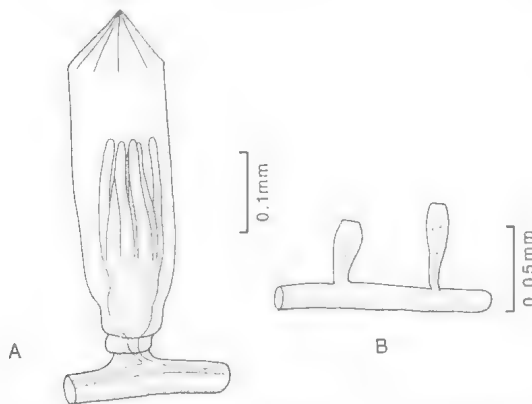


FIG. 7. *Egmundella amirantensis*. A, hydranth; B, nematotheca. Suva barrier reef (QM GL10181).

WORLD DISTRIBUTION

Great Barrier Reef: Low Isles (Pennycuik, 1959), Victoria (Bale, 1913; Blackburn, 1937).

Family TUBULARIIDAE

Tubularia Linnaeus, 1758

Tubularia sp.

A small colony with unbranched stems about 10 mm high and 0.3 mm diameter was obtained under coral rock on Suva Barrier Reef, eastern end, on 25 Jul. 78 (QM GL10180). Hydranths were incipiently fertile with small, 3–5 lobed blastostyles forming just above the aboral ring of tentacles. Not possible to identify to species.

Family ZANCLEIDAE

Zanclea Gegenbaur, 1856

Zanclea sp.

OCCURRENCE IN FIJI

A few zooids on unidentified Bryozoa, under boulders, crest of Suva barrier reef; 29 Mar. 79, 27 Apr. 79.

Order THECATA

Family CAMPANULINIDAE

Egmundella Stechow, 1921

Egmundella amirantensis Millard and

Bouillon, 1973

(Fig. 7)

Egmundella amirantensis Millard and Bouillon, 1973: 40

Egmundella amirantensis Millard and Bouillon, 1973:

Millard 1975: 133

DESCRIPTION

Colony epizoid on other hydroids; stolonial. Hydrothecae arising from hydrorhiza; shortly pedicellate or almost sessile; more or less cylindrical but of variable height; rounded at the base. Operculum composed of an uncertain number of delicate segments, which are not strongly demarcated from each other or from the thecal wall. Diaphragm not observed.

Nematothecae present on the hydrorhiza; tubular, without pedicel; narrowed at base and rounded distally. Long, slender nematocysts sometimes visible. Gonothecae not observed (for description see Millard, 1975).

MEASUREMENTS (μm)

Hydrotheca: height 130–225; diameter 45–65.
Nematotheca: height 35–50.

REMARKS

Our material closely resembles the holotype slide of *E. amirantensis* in the South African Museum (SAM H 2917).

OCCURRENCE IN FIJI

Epizoic on *Tubularia*, Suva barrier reef flat, 25 Jul. 78 (QM GL10181).

WORLD DISTRIBUTION

Southern Africa, Seychelles.

Family HALECHIDAE

Halecium Oken, 1815

The generic name *Halecium*, invalidated in a general ruling on Oken's names by the International Commission on Zoological Nomenclature (1956), has subsequently been declared valid (ICZN, 1982). Hydrothecal regeneration is common in *Halecium*: the original hydrotheca is usually termed primary, the first regeneration secondary, and so on (Millard, 1975).

Halecium sibogae Billard, 1929

(Fig. 8)

Halecium sibogae Billard, 1929: 307.

DESCRIPTION

Colony shrubby; branching irregularly alternate; reaching 40 mm; polysiphonic near the base. Stem and branches divided by oblique nodes into regular internodes, which diverge alternately left and right, creating a slightly geniculate appearance. Each internode bearing a hydrotheca on a distal apophysis, the adcauline side of which is thickened and distinctly comma-shaped in side view. The two series of hydrothecae in one plane or shifted slightly anteriorly. Internodes non-annulated.

Primary hydrotheca sessile, with adcauline wall free from stem; secondary hydrothecae stalked, the pedicels with basal constrictions, slightly gibbous above, narrowed then expanding distad. Hydrothecae shallow with straight sides, widening slightly; margin everted, though the delicate cup is so liable to damage that the everted margin often difficult to see. Diaphragm straight and with a ring of desmocytes (refrinent granules) above.

Gonotheca arising from within a hydrotheca, globular or ovoid, shortly pedicellate. Aperture on short collar, slightly squared, with small indistinct horns at each corner; no accompanying hydranth.

MEASUREMENTS (μm)

Hydrotheca: depth 30–50; marginal diameter 180–220. Internode: length 640–800; width 150–180. Gonotheca: height 1183–1547; maximum width 1019–1310; aperture diameter 255–364.

REMARKS

The gonothecae immediately eliminate other species such as *H. beanii* (Johnston, 1838), *H. halecinum* (Linnaeus, 1758), and *H. sessile* Norman, 1867, with which this species might otherwise be confused. In identifying this material as *H. sibogae*, we have been particularly influenced by Billard's illustration (1929, fig. 1B) and his description of the comma-shaped perisarcal thickening (as seen in side view, see Fig. 8) on the adcauline side of the apophysis which, if present on the other species, is not as obvious. Many of the hydrothecae in the Fiji material do not have the everted margin (as explained above) stressed by Billard.

OCCURRENCE IN FIJI

On coral head, 3–8 m, Frigate Pass, Mbengga leeward barrier reef; reproductive; 2 Nov. 79 (BM 1984.5.17.5; QM GL10182/3).

WORLD DISTRIBUTION

Indonesia (Billard, 1929).

Halecium sp. 1 (Fig. 9)

DESCRIPTION

Colonies small, <3 mm high, variable in shape. Stem monosiphonic; branching irregular, weakly sympodial. Internodes narrow basally, much wider distally; slender or with irregular corrugations at the base. Branches typically arising from posterior surface of internode below. Hydrothecae terminating each internode, with apophysis of the subsequent internode immediately below. Primary hydrothecae sessile; secondary hydrothecae shortly pedicellate. Tiers of secondary hydrothecae common. Pedicel typically symmetrical, often constricted at base and gradually widening distad; apophyses of variable length. Hydrothecae shallow, flaring; margin strongly everted. Diaphragm delicate, with a ring of large desmo-

cytes immediately above it. Gonothecae not observed.

MEASUREMENTS (μm)

Measurements for *H. reflexum* from Vervoort (1968) are in parentheses.

Hydrotheca: marginal diameter 175–270 (120–165); depth 20–50 (13–30). Internode: length 190–460 (175–440).

REMARKS

Athecate internodes were not observed. This material differs from *H. tenellum* Hincks, 1861, and *H. reflexum* Stechow, 1919a, by the irregularly sympodial way of branching, the absence of athecate internodes, and the larger hydrothecae. However, as we have not seen gonothecae, and both of the above species are morphologically very variable, no decision on identity was possible.

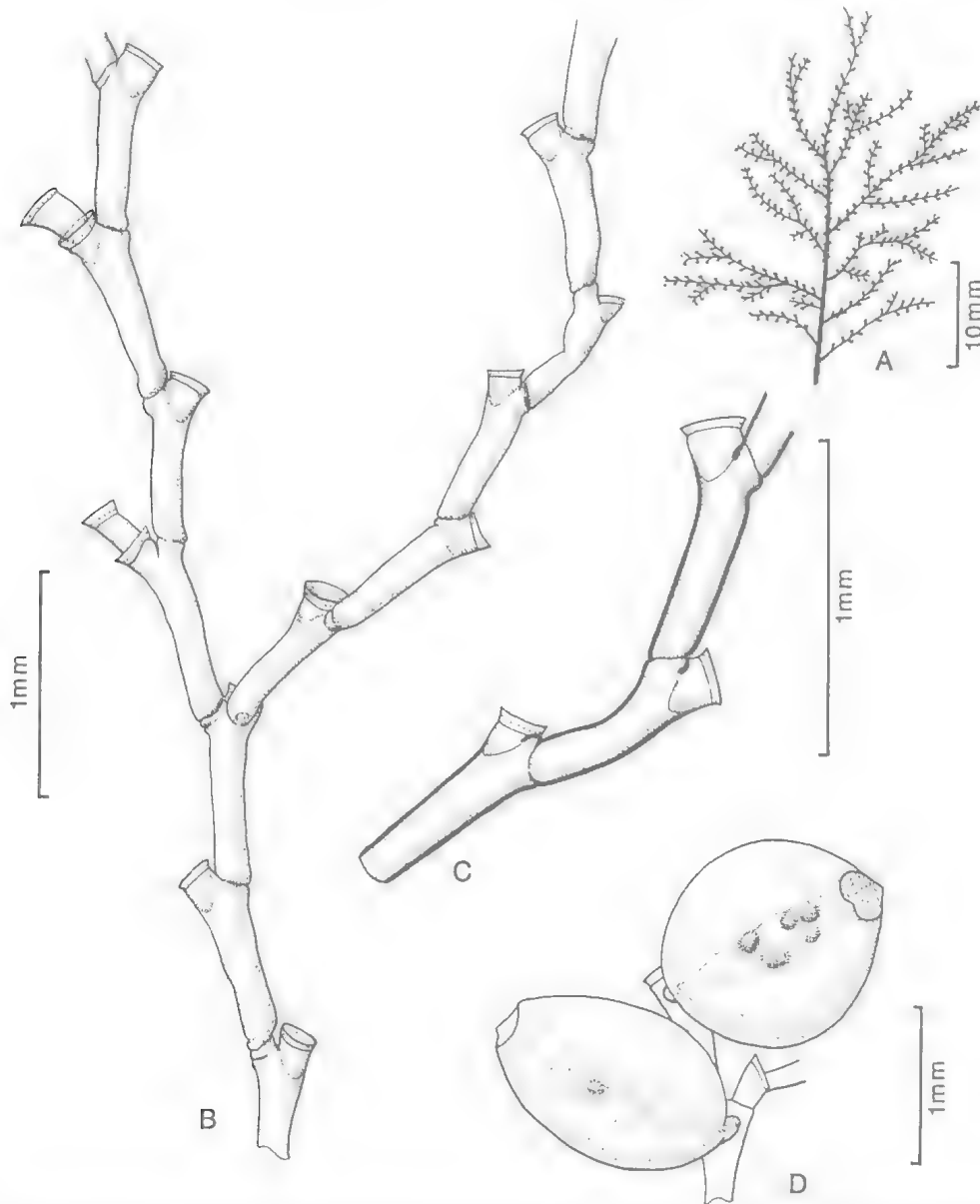
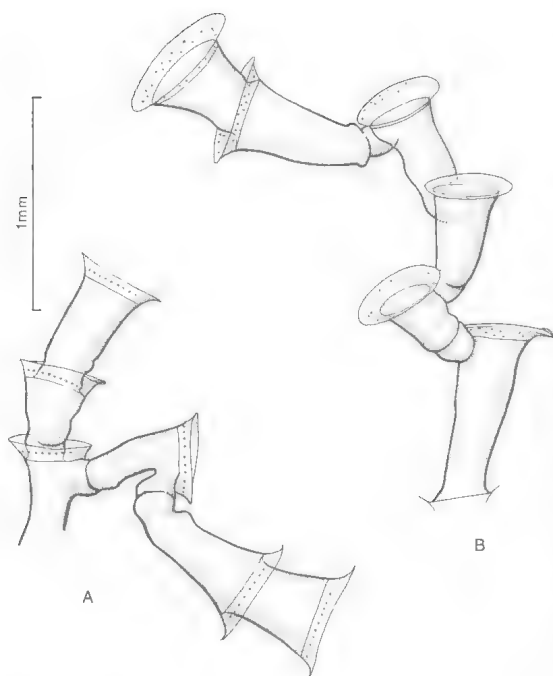
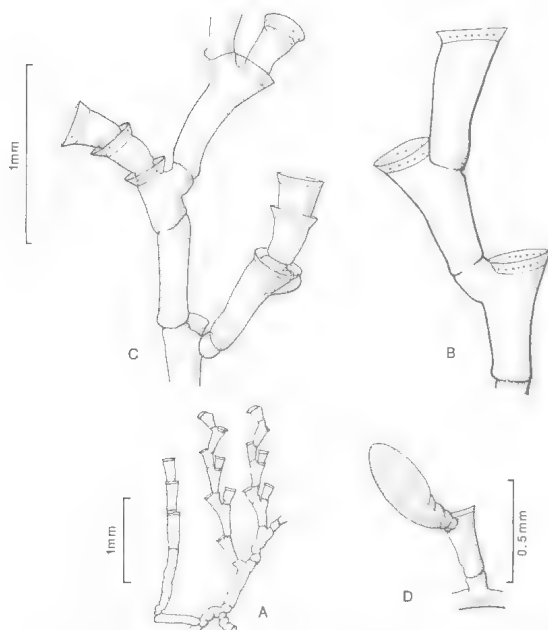


FIG. 8. *Halecium sibogae*. A, habit sketch; B, C, hydrothecae (QM GL10182); D, gonothecae (QM GL10183). Frigate Passage.

FIG. 9. *Halecium* sp. 1. Joske's reef (QM GL10184).FIG. 10. *Halecium* sp. 2. A, habit; B, hydrothecae (QM GL10185); C, hydrothecae (QM GL10186); D, gonotheca (QM GL10185). Great Astrolabe Reef.

OCCURRENCE IN FIJI

Joske's reef, 18 Sep. 78 (QM GL10184).

***Halecium* sp. 2 (Fig. 10)**

DESCRIPTION

Colony small, rarely > 5 mm high; unbranched. Stem monosiphonic; divided into regular thecate internodes by oblique, annulated nodes; each internode with a hydrotheca arising from an apophysis at the distal end; adcauline side of apophyses without thickening. Primary hydrotheca sessile, adcauline wall free from stem. Secondary hydrotheca with a basal constriction, slightly gibbous above and gradually widening distad. Tiers of secondary hydrothecae common. Hydrotheca shallow, with straight sides widening to the margin; margin not everted. Diaphragm straight, with a ring of desmocytes on the hydrotheca above it. Gonothecae on short pedicels, arising singly or in pairs below hydrothecae. Only (probable) male recorded, cylindrical, narrowing proximad, with a small distal aperture.

MEASUREMENTS (μm)

Internode: width 60–90; length 250–390. Hydrotheca: depth 25–35; marginal diameter 110–120. Gonotheca: length 540–570; maximum width 200–230.

REMARKS

The colony form and hydrothecal structure are reminiscent of both *H. beanii* (Johnston) and *H. halecinum* (L.), though the colony size and thecal dimensions in those species are typically much greater than in the present material. The absence of reproductive structures prevents identification.

OCCURRENCE IN FIJI

On coral rock, Suva barrier reef, 7 Jul. 78 (QM GL10185), Great Astrolabe reef, 12 Jul. 80 (QM GL10186).

Hydrodendron Hincks, 1874***Hydrodendron gardineri* (Jarvis, 1922)
(Fig. 11)***Halecium gardineri* Jarvis, 1922: 334*Hydrodendron gardineri* (Jarvis, 1922): Millard 1975: 162

DESCRIPTION

Colony erect, maximum observed height 2.2 mm. Stem monosiphonic and unbranched, divided into internodes of about equal length by trans-

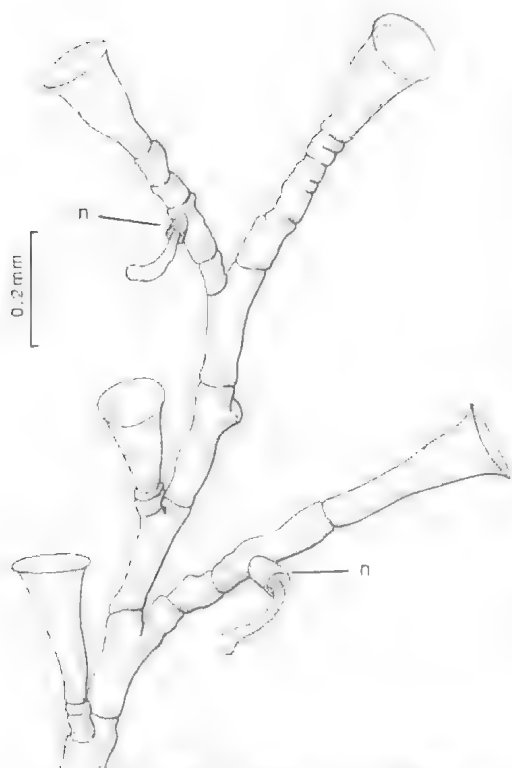


FIG. 11. *Hydrodendron gardineri*. Hydrothecae and nematothecae (n). Suva barrier reef (QM GL10187).

verse or slightly oblique nodes; each internode bearing a single hydrotheca on a distal apophysis of variable length, directed alternately to the left and right, in one plane.

Hydrothecae on short apophyses. These may subsequently be extended into pedicels of variable length which may be divided by transverse septa into segments; corrugated distally. Hydrothecae deep and flaring distad, the margin usually everted. Marginal diameter about one-third of hydrothecal depth. Diaphragm oblique and sloping to the adcauline side. Desmocytes not apparent. Hydranth attached to upper third of hydrotheca.

Nematothecae irregular in occurrence, borne on the hydrorhiza or on internodes of the pedicels, tubular, widening distad, with everted margin. Nematophore with capitulum. Gonothecae not observed (see Jarvis, 1922, and Millard, 1975, for description of male; female unknown).

MEASUREMENTS (μm)

Internode: length 207–600; width 60–87. Hydrotheca: depth 229–340; marginal diameter 136–158. Nematotheca: depth 54–98; marginal diameter 44–54.

VARIATIONS

Solitary hydrothecae may occur, arising direct from the hydrorhiza, typically on a long, distinctly corrugated pedicel.

REMARKS

Our material is rather fragmentary and, in comparison with that described in other accounts, seems poorly developed. It differs in having neither nematothecae on the stem internodes (though in this it agrees with schizotype, BM 23.2.15.9) nor short athecate internodes scattered irregularly along the stem.

OCCURRENCE IN FIJI

Growing over sponge on dead coral, intertidal flat, Suva barrier reef, 25 Jul. 78 (QM GL10187).

WORLD DISTRIBUTION

Chagos Archipelago (type locality) and Mozambique. The present record constitutes a considerable extension to known range.

Family LAFOEIDAE

Hebella Allman, 1888

Hebella dyssymetra Billard, 1933

(Fig. 12)

Hebella dyssymetra Billard, 1933: 6

DESCRIPTION

Colonies epizoid on certain aglaopheniines;

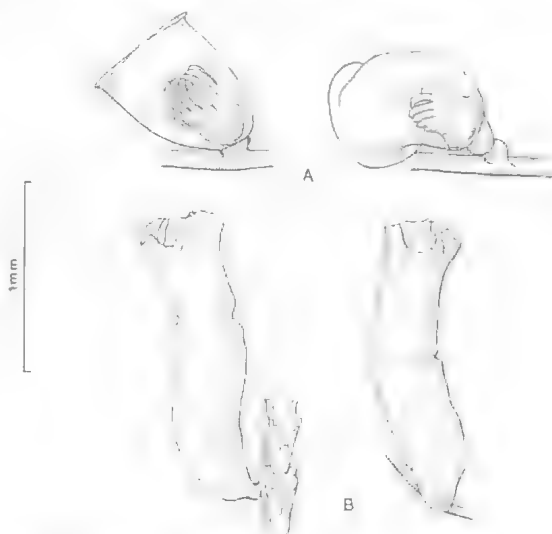


FIG. 12. *Hebella dyssymetra*. A, hydrothecae, Frigate Passage (QM GL10188); B, gonotheca (2 views), on *Lytocarpia phyteuma*, Nukulevu (QM GL10189).

stolonial. Hydorrhiza rounded to flattened, with distinct corrugations; creeping on posterior surface of host stem and under-(athecate) surface of hydrocladia. Hydrothecae arising at irregular intervals, typically asymmetrical and distorted, bending to face forward in relation to the host; shortly pedicellate. Hydrotheca usually 1–1.5 times as deep as wide, campanulate, smooth, delicate; rounded at base, slightly thickened and with a thin, delicate, often indistinct, diaphragm; with slightly everted margin; margin circular, rarely showing signs of renovation. Pedicel with thickened and wrinkled perisarc; it may also bend slightly forward.

Gonotheca almost cylindrical, irregularly corrugated or smooth; truncated distally, tapering basad to a short pedicel; with a 4-valved operculum, loosely fitting and without distinct embayments in rim: aperture distal, squared. Maximum observed number of medusa buds four, arranged one above the other. Colonies in reproductive condition tending to have many irregularly positioned gonothecae but no, or few, hydrothecae.

MEASUREMENTS (μm)

Hydrotheca: marginal diameter 230–280; depth 350–370. Gonotheca: marginal diameter 390–420; depth 1400–1640.

REMARKS

Our material appears referable to var. *trigona* Billard (1942: 68). Though Billard here corrected the spelling of the specific name to *dyssemmetra*, the correction is nomenclaturally not allowable, incorrect orthography not *per se* constituting an 'incorrect original spelling' (Art. 32(c) of the 1985 Code).

OCCURRENCE IN FIJI

On aglaopheniines *Gymnangium hians*, *Lyto- carpia brevirostris* and *L. phyteuma*; windward edge, Great Astrolabe Reef, 26 Jul. 78 and 12 Jul. 80; on *L. phyteuma*, 3–8 m, Frigate Pass, Mbengga barrier reef, 2 Nov. 79 (QM GL10188). Reproductive 27 May 79, Nukulevu (QM GL10189), and 3 Jun. 80, Suva reef (Sta. 25).

WORLD DISTRIBUTION

Red Sea, Seychelles, Malay Archipelago, Great Barrier Reef (Low Is).

***Hebella parasitica* (Ciamician, 1880)**
(Fig. 13)

Lafoea parasitica Ciamician 1880: 673

Hebella parasitica (Ciamician, 1880): Vervoort and Vasseur 1977: 12

DESCRIPTION

Colonies epizoic on halopterine and aglaopheniine hydroids; stolonial. Hydorrhiza slightly rounded to flattened, with few corrugations; creeping on posterior surface of host stem and undersides of hydrocladia. Hydrothecae arising at irregular intervals on pedicels of variable length. Pedicels widening to hydrothecal base, thickened, with a wrinkled perisarc, often spirally twisted. Hydrotheca large, deeply campanulate, 1.5–1.5 times deep as wide, widening distally, smooth or irregularly corrugated; rounded but asymmetrical at base, slightly more thickened on one side than the other, without a distinct diaphragm. Margin strongly everted, circular, often renovated. Gonothecae not observed but have been described, together with the medusa, by Boero (1980).

MEASUREMENTS (μm)

Hydrotheca: depth 640–1200; marginal diameter 400–710; pedicel length 200–560.

REMARKS

This material looks very similar to that illustrated by Vervoort and Vasseur (1977), although ours is considerably larger; however, size is known to be variable in this species.

OCCURRENCE IN FIJI

Recorded on *Antennella secundaria* and *Aglaophenia postdentata*, boulder zone, Suva barrier reef, 27 Apr. 79 and 13 Jun. 79; on *A. postdentata* and *Macrorhynchia philippina* from Ndeumba

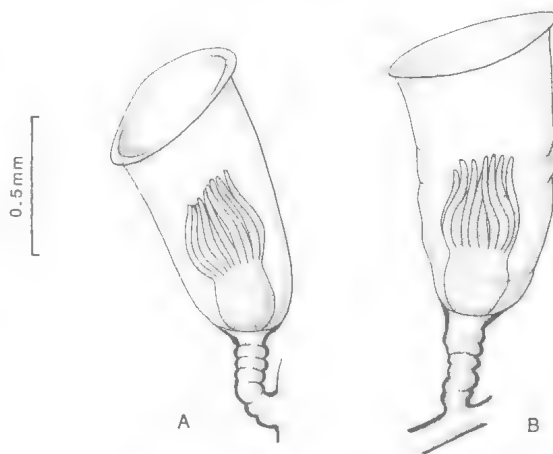


FIG. 13. *Hebella parasitica*. Ndeumba (QM GL10190), on *Macrorhynchia philippina*.

fringing reef, 20 Aug. 78 (QM GL10190) and 18 Mar. 79.

WORLD DISTRIBUTION

Warm water: Mediterranean and eastern Atlantic, Indo-West Pacific to French Polynesia (Vervoort and Vasseur, 1977).

Hebella scandens (Bale, 1888) (Fig. 14)

Lafoea scandens Bale, 1888: 758

Hebella calcarata (A. Agassiz): Hirohito 1969: 14

Hebella scandens (Bale, 1888): Millard 1975: 182

DESCRIPTION

Colonies epizoic on various sertulariids (see below); stolonial. Hydrotheca shortly pedicellate, cylindrical, with nearly parallel sides slightly constricted below the margin; of variable height, usually 2.5–4 times as deep as wide; smooth or with slightly irregular outline, asymmetrical and upright but often distorted, with the upper half of hydrotheca at an oblique angle to lower (especially noticeable when the colony is epizoic on *Dynamena crisioides* and the hydrotheca curls forward over the hydrotheca of the host); margin circular, slightly everted, invariably oblique and renovated. Annular thickening at the base of the hydrotheca distinct, diaphragm delicate. Pedicel smooth or corrugated, thickened. Gonothecae not observed (but described by Hirohito, 1969 and Millard, 1975).

MEASUREMENTS (μm)

Measurements for 'normal'; 'small'; Vervoort and Vasseur (1977); and Mammen (1965) respectively. Hydrotheca: depth 675–850, 340–355, 390–460, 350–370; marginal diameter 150–170, 90–105, 150–160, 140–160.

REMARKS

The Fijian material closely resembles the descriptions and illustrations of previous authors; especially var. *contorta* Marktanner-Turner-etscher, 1890, discussed by Vervoort and Vasseur (1977). Normal sized specimens grow on sertulariids and certain other hydroids, notably *Syntheicum samauense*. The smallest specimens have dimensions similar to those described in *H. scandens*, but also to *H. thankasseriensis* Mammen, 1965, a species endozoic in *Dynamena thankasseriensis* Mammen, 1965. Some of Mammen's material had hydrothecae, as opposed to a hydorrhiza, that were not enclosed by the host.

Millard (1975) has reported an instance in which the stolon of *H. scandens* lay within the perisarc of the host; however, since *H. scandens* has never been reported as truly endozoic, it is probably best to recognize both species.

OCCURRENCE IN FIJI

Found frequently (occurrences in parentheses) on sertulariids collected from reefs in southeast Viti Levu (Suva, Joske's and Ndeumba reefs). Hosts: *Thyroscyphus fruticosus* (4) (QM GL10191), *Dynamena crisioides* (3), *D. cornicina* (1), and *Salacia tetracythara* (1); also present on a sample of *D. crisioides* from London pier, Christmas I. (Line group), 16 Feb. 79. The small specimens came from Ndeumba on *Dynamena quadridentata*, *Sertularia orthogonalis* n. sp. and *S. ligulata*, 28 Aug. 78 (QM GL10231) and 8 Jul. 79.

WORLD DISTRIBUTION

Nearly cosmopolitan. Type locality, New South Wales.

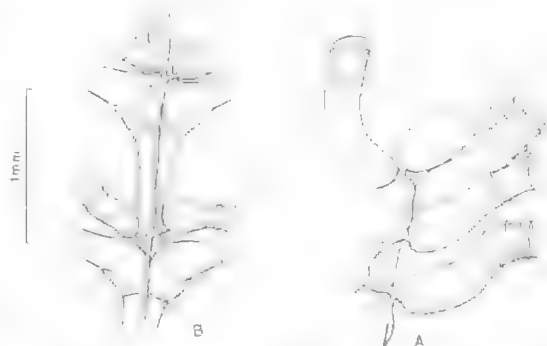


FIG. 14. *Hebella scandens*. A, hydrothecae of normal form, on *Thyroscyphus fruticosus*, Suva barrier reef (QM GL10191); B, small form on *Sertularia orthogonalis* sp.n. Ndeumba (QM GL10231).

Zygophylax Quelch, 1885 *Zygophylax rufa* (Bale, 1884) (Fig. 15)

Campanularia rufa Bale, 1884: 54

Lictorella rufa (Bale, 1884): Vervoort and Vasseur 1977: 15

Zygophylax rufa (Bale, 1884): Rees and Vervoort 1987: 55

DESCRIPTION

Colonies pinnate, stems and hydrocladia in one plane; reaching 50 mm. Stems polysiphonic, slightly geniculate distally, branching at the base;

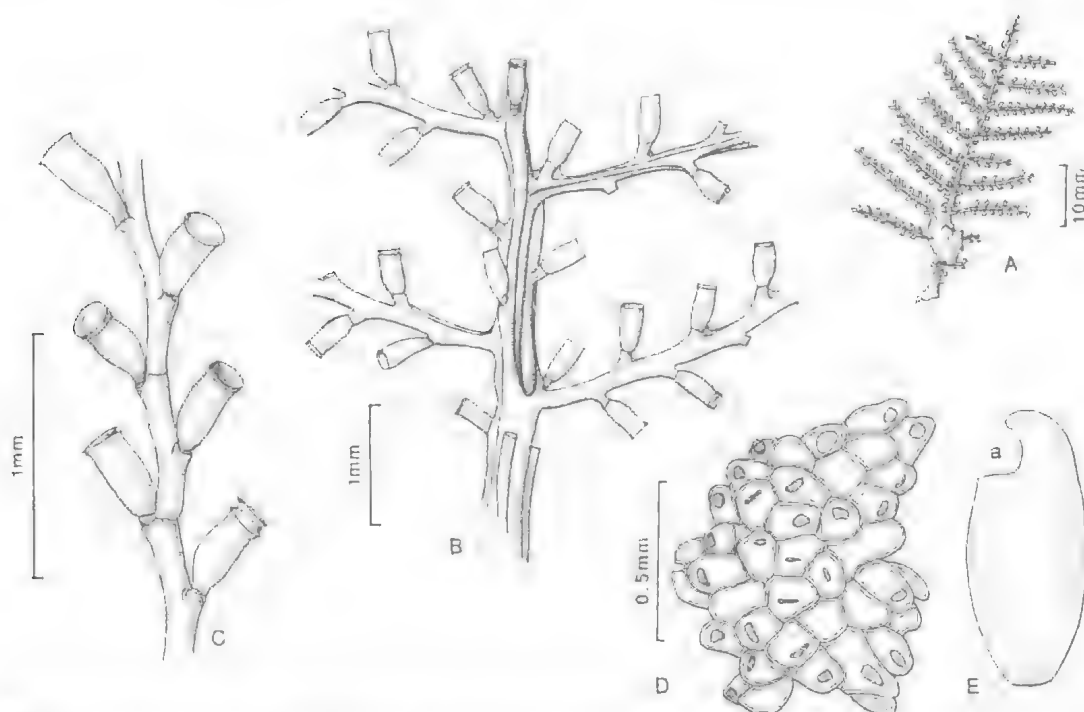


FIG. 15. *Zygophylax rufa*. A, habit sketch; B, part of stem with hydrocladia; C, part of hydrocladium (B, C, QM GL10193); D, coppinia; E, single gonotheca in profile, its aperture (a) at top left. (D, E, QM GL10194). Ndeumba.

giving off hydrocladia and hydrothecae alternately from the axial tube. Hydrocladia at a wide angle to the stem, arising below every second or third cauline hydrotheca (the apparently axillary hydrotheca being on the hydrocladium); typically lightly polysiphonic basally and monosiphonic distally; generally without nodes.

Hydrocladia bearing alternate, antero-lateral hydrothecae on short apophyses, each separated from hydrotheca on pedicel by a partial node. Pedicel short and slightly more slender than the apophysis. Hydrotheca deeply campanulate, narrowing to apophysis, with adcauline wall slightly convex and abcauline wall nearly straight; widening to smooth, everted margin; often renovated, sometimes unequally. Walls thickened. Diaphragm distinct, transverse.

Nematotheca tubular, short; probably caducous; one present at the hydrocladial base, near the axillary hydrotheca or, more commonly, a small perisarc pore in this position. Also found occasionally on apophysis or pedicel of cauline hydrothecae.

Coppinia on the front of a stem at the colony base. Constituent gonothecae polygonal (5- or 6-merous) in cross-section; narrowed proximally and rounded distally, with a small, hooded, disto-

lateral aperture. Stem a mahogany colour, hydrothecae yellowish.

MEASUREMENTS (μm)

Hydrotheca: depth 290–390; marginal diameter 130–155; diaphragm diameter 50–95; pedicel length 40–85.

VARIATIONS

Large colonies common on coral rock, small ones occasionally found epizoid on *Macrorhynchia phoenicea*. Hydrocladia may have irregular transverse nodes. Cauline hydrothecae at the colony base are arranged irregularly, not in one plane; and they arise from both axial and peripheral tubes. The hydrothecae often appear sessile, since the base merges directly with the apophysis (see also fig. 7 in Vervoort and Vasseur, 1977).

REMARKS

This species has been well redescribed by Vervoort and Vasseur (1977). The coppiniae in our colonies are not split into upper and lower sections but form one complete mass covering the front, and sometimes the back, of the stem; all parts contained reproductive products. In a recent review of species, Rees and Vervoort (1987)

concluded that the nominal genus *Lictorella* should not be retained separate from *Zygophylax*.

OCCURRENCE IN FIJI

Widely distributed at LWST and in shallow water: Suva barrier (BM 1984.5.17.13), Joske's, Ndeumba fringing (QM GL10193), Great

Astrolabe, and Mbengga barrier reefs (BM 1984.5.17.11, 11a); with coppiniae, Ndeumba, 20 Aug. 78 (BM 1984.5.17.12; QM GL10194).

WORLD DISTRIBUTION

Torres Strait, Great Barrier Reef (Holbourne l.), and French Polynesia (Tuamotu archipelago).

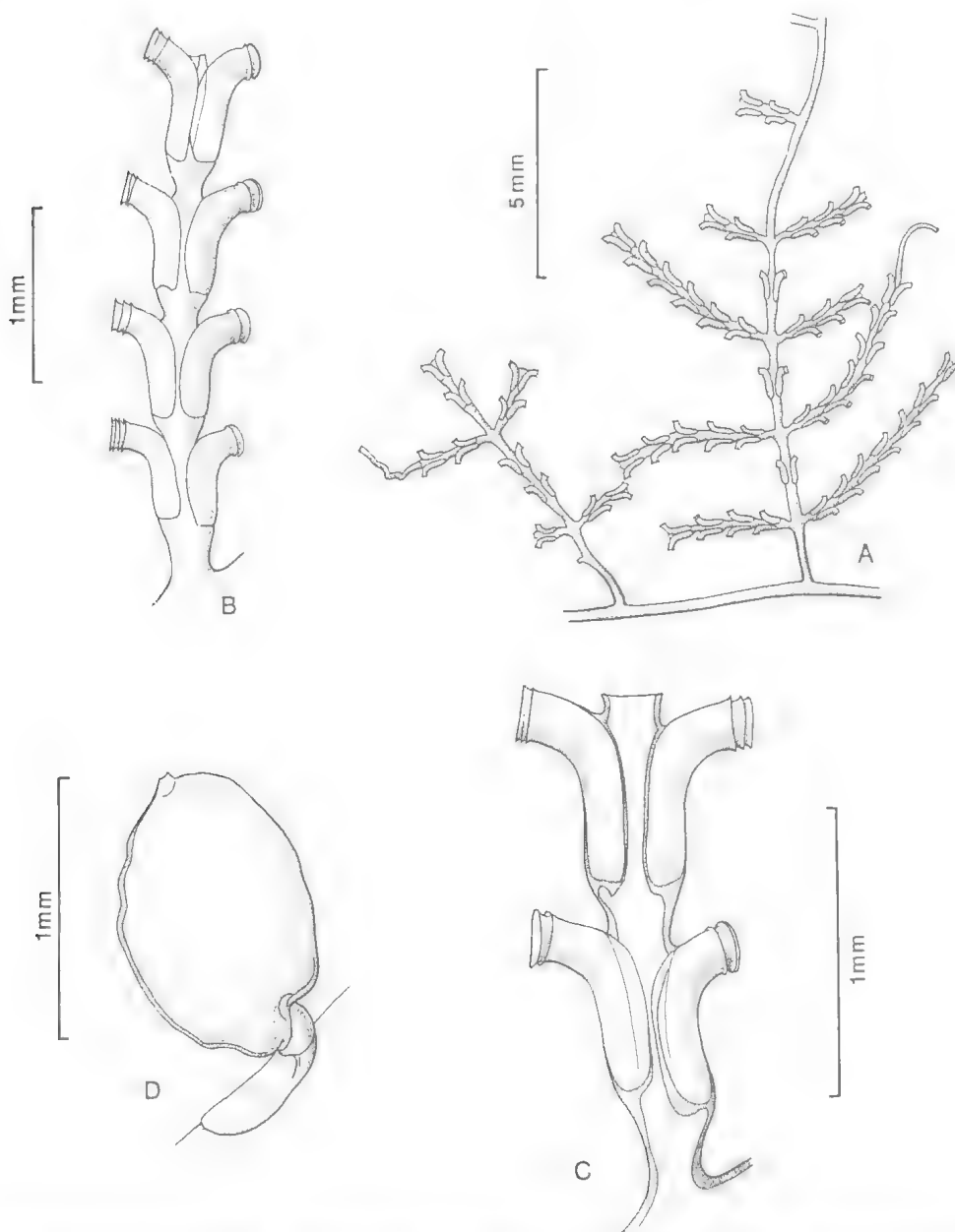


FIG. 16. *Syntheceum samauense*. A, erect stems; B, C, hydrothecae (QM GL10196); D, gonotheca (QM GL10195). Great Astrolabe Reef.

Family SYNTHECIIDAE
Synthecium Allman, 1872

Synthecium was introduced by Allman on p. 229 of his monograph, the publication dates of which (1871–72) do not correspond with the division of the work into two parts. The first instalment of Part I — *The Hydroida in general*, was published in 1871 and the residue (p. 155–231) in 1872 together with Part II — *The genera and species of the Gymnoblastera*.

Synthecium samauense Billard, 1924
 (Fig. 16)

Synthecium samauense Billard, 1924: 646
S. samauense: Billard 1925: 132

DESCRIPTION

Stems erect, monosiphonic; reaching 20 mm; arising from hydrorhiza. Hydrocladia pinnately arranged, in one plane. Stem divided by indistinct 'nodes' into internodes of variable length, each with a pair of opposite hydrocladia distally and up to two pairs of opposite hydrothecae proximally. Basalmost internode either without hydrocladia and hydrothecae or with hydrocladia but without hydrothecae: terminated by a transverse node.

Hydrocladia unsegmented, often terminating in a tendril-like extension of variable length; this resembles and may fuse with the hydrorhiza, giving rise to irregularly-spaced solitary hydrocladia. Hydrothecae arranged in opposite to subopposite pairs: members of a pair typically separated in proximal part of stem, both in front and behind, grading distally to pairs being contiguous in front. Consecutive hydrothecae not overlapping. Hydrothecae smooth, tubular, not widening to the margin; adnate for about four-fifths of their vertical height, curving abruptly outwards at 60–70° to the hydrocladial axis. Abcauline wall thickened and nearly parallel with the hydrocladial axis in its lower part, but with a slight basal swelling. Length of free portion variable; margin without cusps, everted and invariably renovated; perisarc in the axil thickened.

Gonotheca arising from within hydrotheca, smooth, pedicellate; asymmetrically ovate, flattened in one plane. Wall thickened, with small distal aperture on short conical collar.

VARIATIONS

Colonies have either large or small hydrothecae (see 'Measurements'). The nodes are more apparent than real, being produced by stem renovation.

MEASUREMENTS (μm)

Measurements for 'large' and 'small' respectively. Hydrotheca: adnate length 520–610, 400–440; free adcauline length 210–390, 200–270, marginal diameter 160–210, 130–150. Distance between hydrothecae: 150–240, 130–280. Diameter across thecal pair: 330–370, 260–310. Gonotheca (female): length 990–1200 ('large'); maximum width (2 only) 774 ('large').

REMARKS

Our material agrees closely with Billard's (1925) and Vervoort and Vasseur's (1977) descriptions, the Fijian material similarly having hydrothecae of two sizes. The fertile female colonies all had hydrothecae of the larger size, though whether this represents sexual dimorphism we cannot say: none of the smaller specimens was fertile.

OCCURRENCE IN FIJI

Found on coral rock: Thangilai reef edge, 28 Apr. 79; Joske's reef, reproductive, 18 Sep. 78 (BM 1984.5.17.14); windward Great Astrolabe reef, 24 Jul. 78 (QM GL10196), reproductive (BM 1984.5.17.15; QM GL10195), and 12 Jul. 80.

WORLD DISTRIBUTION

Semau I., Timor, Indonesia (type locality); New Caledonia and French Polynesia.

Family CAMPANULARIIDAE

Clytia Lamouroux, 1812
Clytia edentula sp. nov.
 (Fig. 17)

MATERIAL EXAMINED

HOLOTYPE: Slides (QM GL10197/8) collected 13 Dec. 1978.

PARATYPES: Slide (BM 1988.11.11.1), and preserved specimens (BM 1984.5.17.9), also from the type locality, 13 Dec. 1978.

TYPE LOCALITY: Ndeumba fringing reef, Pacific Harbour, Viti Levu; on *Sargassum*, 13 Dec. 78 (reproductive).

DERIVATION OF NAME

L., *edentulus*, toothless; referring to the rim of the hydrotheca.

DESCRIPTION

Colony stolonial, with anastomoses. Pedicels unbranched; of variable height, 1.2–2.9 mm; closely annulated at base, mid-region smooth, distally with corrugations terminating in a moniliform series of up to four flattened vesicles.

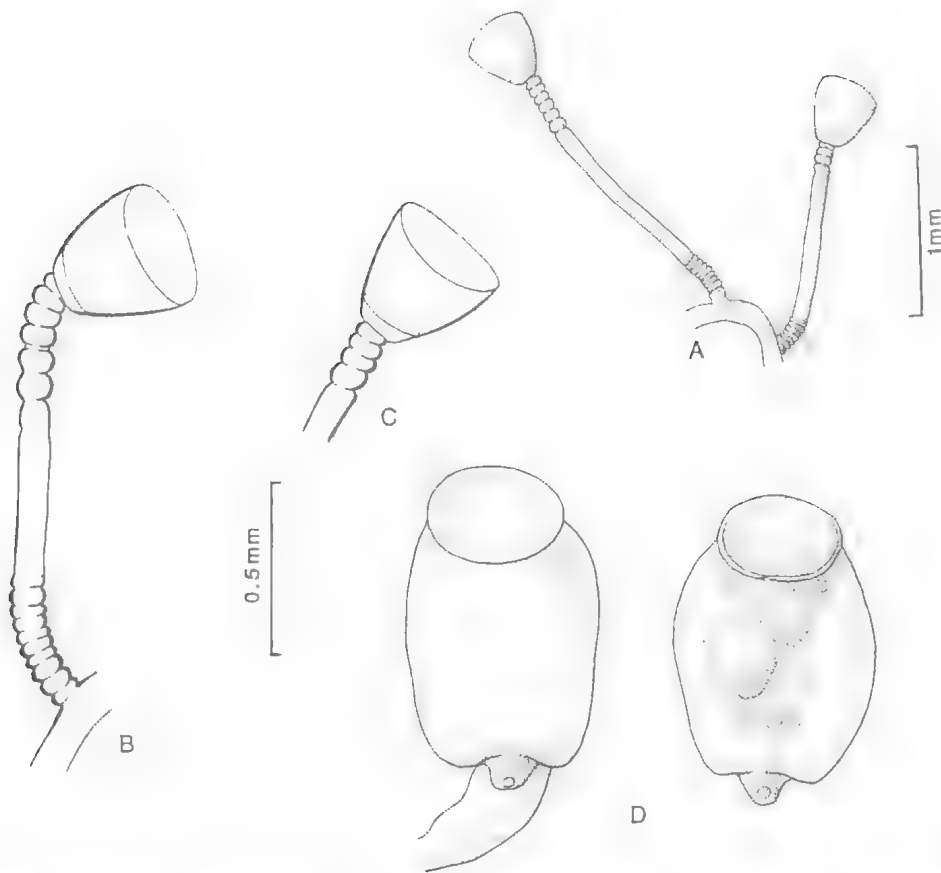


FIG. 17. *Clytia edentula* sp.n. Holotype. A-C, hydrothecae; D, gonothecae. Ndeumba (QM GL10197, 10198).

Hydrotheca obconical, with straight, unthickened walls; depth about equal to diameter; margin smooth, or sometimes with 6–8 indistinct, flat and rounded cusps; diaphragm delicate, distinct, transverse and separating off a shallow, broad basal chamber; ring of large refringent desmocytes above diaphragm (as in Haleciidae), prominent in empty hydrothecae; often with a thickened perisarcular annulus at the diaphragm, as in *C. simplex* Congdon, 1907.

Gonotheca arising directly from hydrorhiza; smooth, ovoid-spherical with truncated base which constricts sharply to short, curved pedicel; wide aperture on short collar.

MEASUREMENTS (μm)

Hydrotheca: depth 350–450; marginal diameter 300–450. Gonotheca: length 780–830; marginal diameter 350–370, maximum width 600–630.

VARIATIONS

The number of vesicles immediately below the

hydrotheca varies from one to four, making it difficult to regard the terminal one as a sub-hydrothecal spherule as defined by Cornelius (1982), mostly in the Campanulariinae; the extent of corrugation below them also variable. The mid-region of the pedicel may be corrugated.

REMARKS

The lack of prominent marginal cusps is a feature shared with *C. hummelincki* (Leloup, 1935), *Orthopyxis integra* (Macgillivray, 1842), and *O. crenata* (Hartlaub, 1901b). In comparison with the present species, these have much less annulation of the pedicel, and the gonothecae are markedly different. Furthermore, species of *Orthopyxis* L. Agassiz, 1862, are characterized by presence of a sub-hydrothecal spherule and absence of a diaphragm (Cornelius, 1982). Using these criteria, therefore, despite the superficial similarity, the present species should not be referred to *Orthopyxis*. The gonothecae in our material do not clearly show the formation of

medusae but the wide aperture suggests that free medusae are released.

OCCURRENCE IN FIJI

Type locality only.

Clytia (?) *gracilis* (M. Sars, 1850) (Fig. 18)

Laomedea gracilis M. Sars, 1850: 138

C. sarsi Cornelius, 1982: 78 [nom. nov. pro *Laomedea gracilis* Sars, non Dana]

C. hemisphaerica (L., 1767) f. *gracilis* (sensu M. Sars, 1851): Östman, 1983

C. gracilis (Sars, 1850): Cornelius and Östman, 1986: 165 [proposed nomen conservandum]

DESCRIPTION

Pedicels unbranched, 1.0–1.5 mm high, closely annulated at the base, and with up to three flattish annulations distally. Hydrotheca campanulate, expanding to the margin, height 1.5–2.0 times top diameter. Margin with 10–12 pointed, oblique cusps. Diaphragm delicate but not thin; transverse, separating off a broad, shallow basal chamber. Gonotheca borne on the hydrotheca, on pedicel of up to three annulations; smooth,

elongate, tapering proximad, truncated distally; aperture distal, broad, above a slight constriction.

VARIATIONS AND REMARKS

Although this material closely resembles the original illustration of *C. obliqua* Clarke, 1907, and the subsequent drawings of Fraser (1936), Picard (1950) and Hirohito (1969), examination of type material (Smithsonian Institution No. 29616) from Perico Island (Gulf of Panama) brings us to agree with Cornelius (1982) that *C. obliqua* is conspecific with *C. linearis* (Thornely, 1899). The type colonies are branched and the hydrothecae tall. While it was not possible to observe the characteristic stiffening strips (see *C. linearis*), the non-oblique cusps are certainly more like those of *C. linearis* than our material.

Oblique hydrothecal cusps are a characteristic feature of *C. gracilis* Sars, 1850 (= *C. sarsi* Cornelius, 1982) and probably also of *C. pelagica* van Breemen, 1905. However, in contrast to the illustration of this species (as *C. hemisphaerica* f. *gracilis*) by Östman (1983, Pl. 3, fig. 5), the diaphragm in our specimens is relatively thick and more akin to Östman's (1983, Pl. 2, fig. 3) *C. h. johnstoni* (Alder, 1856). The thickness of the diaphragm is, however, apparently variable in both taxa and cannot be used with certainty to dis-

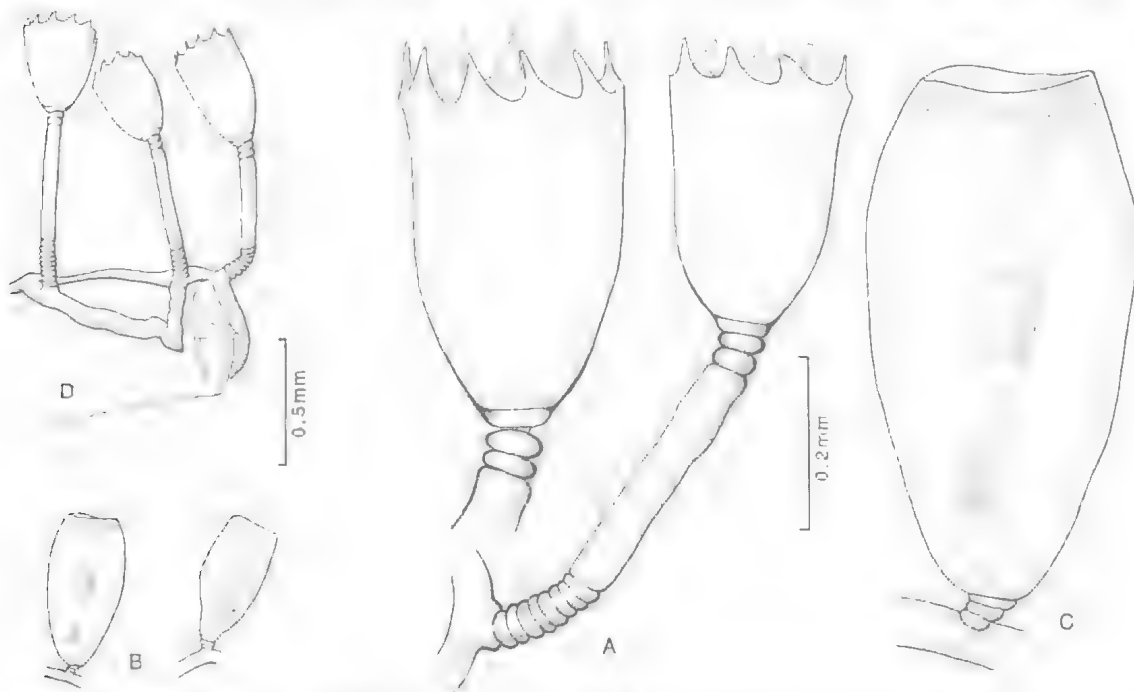


FIG. 18. *Clytia* ?*gracilis*. A, hydrothecae, Nukumbutho reef; B, C, gonothecae; D, habit sketch: part of colony growing on hydrotheca of *Thyroscyphus fruticosus*, Suva Barrier Reef (QM GL10199).

tinguish one from the other. Smooth gonothecae have traditionally been associated with *gracilis* (e.g., Vervoort, 1968; Millard, 1975; Östman, 1983), ribbed gonothecae with *johnstoni* (e.g., Pennycuik, 1959; Millard, 1975; Östman, 1983). Ralph (1957), however, described New Zealand *johnstoni* with variably ribbed gonothecae. Acute, oblique hydrothecal cusps are characteristic of *gracilis*, rounded and non-oblique cusps of *johnstoni* (see Millard, 1975; Östman, 1983), though Vervoort's (1968) illustration of *C. pelagica* (= *C. gracilis*) shows rounded, non-oblique cusps. Examination of the South African Museum's '*C. hemisphaerica*' reveals variations in both of these supposedly distinguishing characters, such that existing concepts of the distinctions between the morphology of the two taxa become blurred. Vervoort (1959, 1968, 1972) maintained that the hydrothecae of *gracilis* have a unique, undulating cross section, noted also by Millard (1975), but this character was not observed in the Fijian specimens.

The status of these taxa has been very confused (see Cornelius, 1982). Vervoort (1959, 1968, 1972) regarded *C. hemisphaerica* and *C. gracilis* as separate species. So now do Cornelius and Östman (1986), on the grounds of nematocyst structure and differences between the hydranths, medusae and life cycles. Millard (1975) treated them as forms of one species.

Records of '*C. johnstoni*' are common from tropical and temperate waters. Those of *C. gracilis* tend to be concentrated around northern European waters though records, under various names, exist from the Atlantic coast of the Americas (Fraser, 1944; Vervoort, 1972), the Caribbean (Deevey, 1954; Vervoort, 1968), West Africa (Vervoort, 1959), South Pacific (Hartlaub, 1905), eastern Pacific (Fraser, 1948), and India (Mammen, 1965). Taking such records at face value, there is no reason why *gracilis* should not occur around Fiji.

Unfortunately, we cannot investigate the nematocysts and allozymes of our preserved material

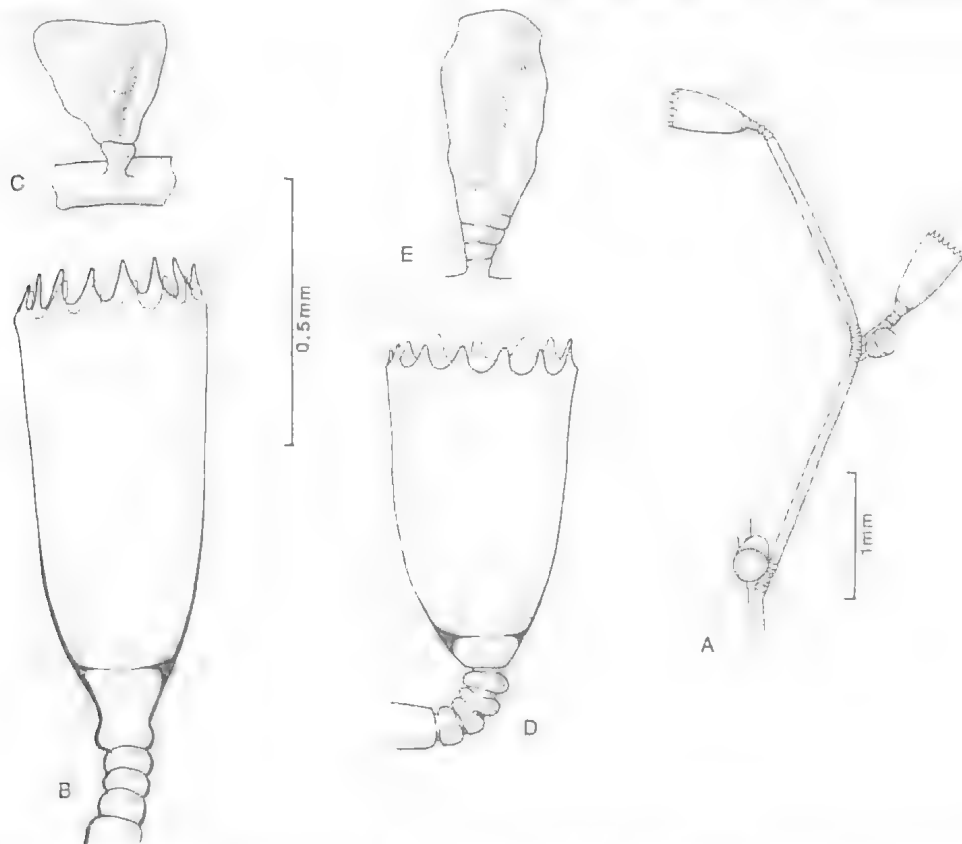


FIG. 19. *Clytia hemisphaerica* f. *johnstoni*. A, part of colony showing sympodial branching; B, hydrotheca; C, gonotheca (? partly developed) (A-C, QM GL10200, Mba); D, hydrotheca; E, gonotheca (both from QM GL10201, with unbranched pedicels, Suva Barrier Reef).

(cf. Östman, 1979, 1982), so our attribution to *C. gracilis* is tentative. That the number of described *Clytia* ('*Phialidium*') nominal medusa species overall exceeds the accepted number of hydroid species (P.F.S. Cornelius, *pers. comm.*), and that Bouillon (1984) has recorded eight *Clytia* medusa species from the Bismarck Sea compared with our four hydroid species from Fiji, are indicative of the work still to be done on this genus.

MEASUREMENTS (μm)

Hydrotheca: depth 430–500; marginal diameter 200–250. Gonotheca: length 550–600; marginal diameter 180–240.

OCCURRENCE IN FIJI

On *Thyroscyphus fruticosus* (sand population)

on the reef flat near Nukumbutho Pass, 23 Sep. 79 (QM GL10199).

Clytia hemisphaerica (Linnaeus, 1767) (Figs. 19–21)

Medusa hemisphaerica Linnaeus, 1767: 1098

Epenthes folleatum McCrady, 1857: 191 [medusa]

Clytia Johnstoni Alder: Hincks 1868: 143

Clytia hemisphaerica (Linnaeus, 1767): Millard 1975: 217; Cornelius 1982: 73; (cum part. syn.); Cornelius and Östman 1986: 164.

DESCRIPTION

Colony stolonial to shortly erect. Pedicels typically simple, though occasionally with one sympodial branch; of variable height up to 6 mm;

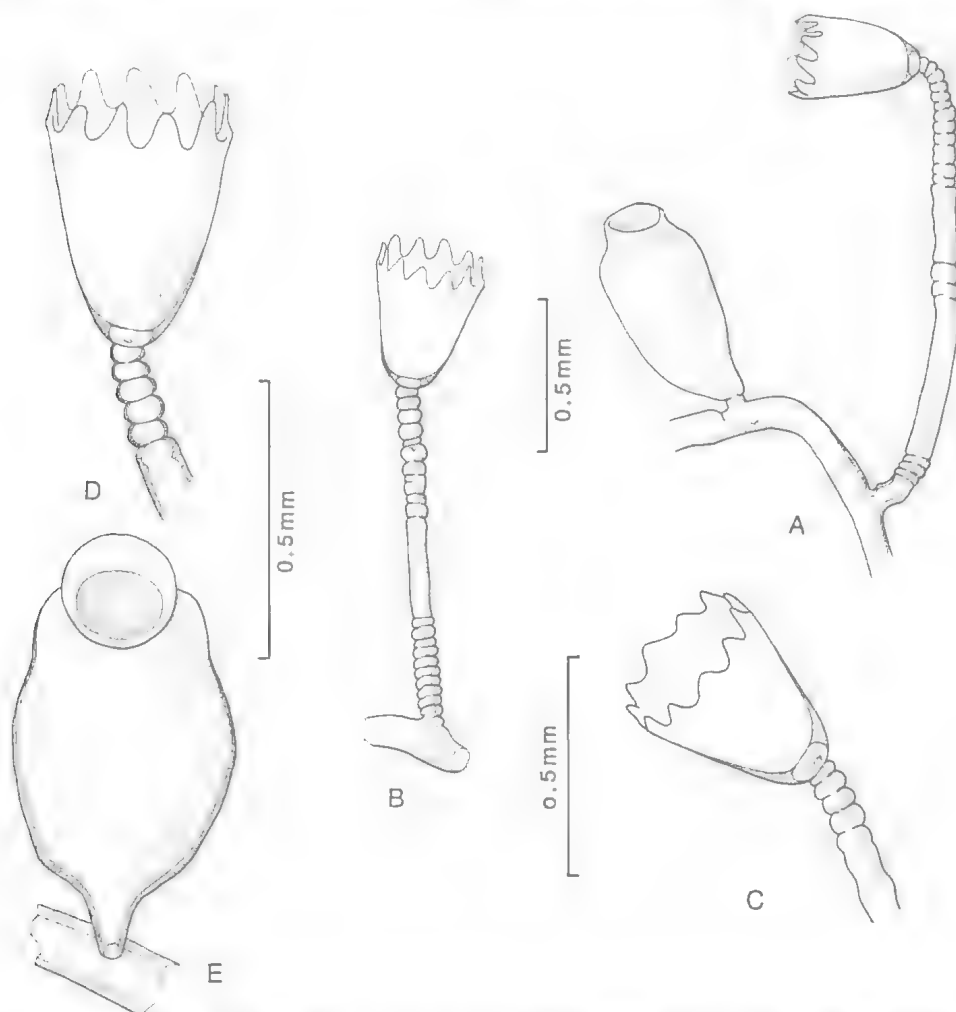


FIG. 20. *Clytia hemisphaerica* f. *folleata*. A, part of stolon with hydrotheca and gonotheca; B, C, D, hydrothecae showing various amounts of annulation; E, gonotheca. QM GL10202, Ndeumba.

closely annulated proximally and distally, smooth in mid-region (see Fig. 19).

Hydrotheca deeply campanulate, expanding little to margin; depth usually 2–3 times diameter. Margin with 10–18 cusps; these tall, distinctly pointed; often with short but distinct longitudinal ridge at base of the rounded bays. Diaphragm delicate, distinct, transverse or slightly oblique, separating off a bell-shaped basal chamber. Thecal walls typically unthickened.

Gonotheca borne on hydrorhiza and, if the colony is erect and branched, also on the pedicel, just above its origin from the stem. Variable in shape, usually elongate-ovoid, tapering slightly proximad and truncated distally; on a short annulated pedicel. Aperture distal, wide; often a variably distinct constriction below, giving the impression of a collar.

VARIATIONS AND REMARKS

This is recognized as an exceptionally variable species (Cornelius, 1982) and the material from Fiji is no exception. The mid-region of the pedicel may be irregularly annulated or corrugated. The diaphragm is at an inconstant distance from the hydrothecal base, and the basal chamber of correspondingly variable shape. The marginal cusps vary in both number and shape.

The above colonies, following the account of Östman (1983), we refer to *f. johnstoni*. Specimens from Ndeumba (13 Dec. 78 on red algae; Fig. 20) are very different, having obconical hydrothecae which are distinctly thickened at the diaphragm, much as in the manner of *Campanularia* sp., except that the thickening is double, the perisarcular ring being a later addition. The hydrothecal pedicel terminates in up to five flattened vesicles. The gonotheca, borne on a non-annulated pedicel, is smooth, elongate, tapering proximad and rounded distally; and its aperture is on a distinct collar. This (Ndeumba) material resembles more closely the illustrations of *C. simplex* Congdon, 1907, and *C. folleata* (McCrady) in Vannucci (1946) than those of nominal *C. hemisphaerica*. However, *C. simplex* has been regarded conspecific first with *C. noli-formis* McCrady by Fraser (1944) and subsequently with *C. hemisphaerica* (by Cornelius, 1982, who included a lengthy taxonomic discussion). Schmidt and Benović (1977) regarded *C. folleata* as an aberrant form of *C. hemisphaerica*, though Cornelius (1982) opined that more material was necessary before this could be substantiated. Following Östman (1983), we distinguish this as *f. folleata*.

In a second variant found around Fiji (Fig. 21)

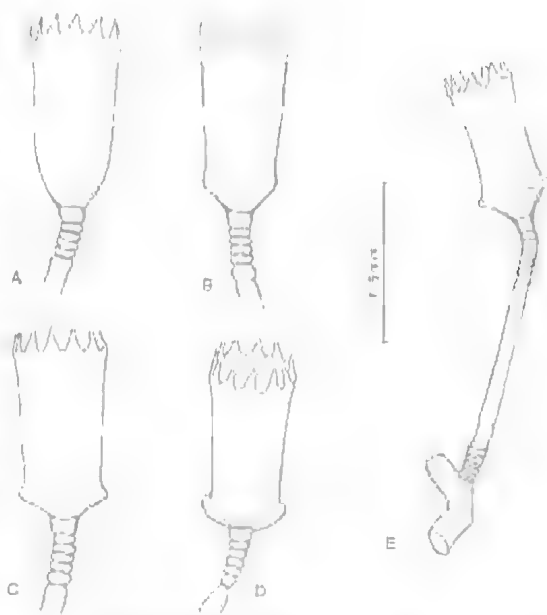


FIG. 21. *Clytia hemisphaerica*, aberrant forms. A-D, four hydrothecae showing range in form within one colony; QM GL10203, Mba; E, hydrotheca; QM GL10204, Ndeumba.

the hydrothecae abruptly reach their full width just above the diaphragm. Thereafter the walls are straight and more or less parallel; the margin is slightly flared, with eight pointed cusps. This variation was observed twice, once as part of an elsewhere normal *f. johnstoni* colony.

MEASUREMENTS (μm)

Measurements for *f. johnstoni*; *f. folleata*; and aberrant form respectively. Hydrotheca: depth 400–900, 350–450, 510–620; marginal diameter 200–350, 250–300, 170–210; diameter at basal ridge —, —, 210–240. Gonotheca: length 340–1000, 550–770, —; marginal diameter 140–250, 180–240, —; maximum width 170–280, 350–410, —.

OCCURRENCE IN FIJI

Forma johnstoni: On sea grass (*Halodule pinifolia*), intertidal sand flats, Suva Point, March 1978 (BM 1984.5.17.8; QM GL10201); on *Dynamena crisioides*, Suva barrier reef, 11 Apr. 78, on *Gracilaria* sp., intertidal sand flats, mouth of Mba river, 9 Nov. 78 (reproductive) (BM 1984.5.17.7; QM GL10200); on *Sargassum* sp., 7 May 78 (reproductive); on *Lyrocarpia phyteuma*, windward Great Astrolabe Reef, 12 Jul. 80. Also on *D. crisioides* from London pier, Christmas I.

(Line group), 16 Feb. 79. *Forma folleata*: on red algae, 13 Dec. 78, Ndeumba fringing reef (BM 1984.5.17.6; QM GL10202).

WORLD DISTRIBUTION

Nearly cosmopolitan in coastal waters.

Clytia linearis (Thornely, 1899) (Fig. 22)

Obelia linearis Thornely, 1899: 453

Campanularia gravieri Billard, 1904: 482

Campanularia(?) obliqua Clarke, 1907: 9

Clytia gravieri (Billard, 1904): Millard and Bouillon 1973: 51; Millard 1975: 215

Clytia linearis (Thornely, 1899): Cornelius 1982: 84 (cum syn.)

DESCRIPTION

Colonies stolonial, with erect sympodia; monosiphonic (but sometimes thickened at base), to 9 mm; pedicels with 4–6 close annulations at base and at origin of branches, but with a variable number distally, always extending for a distance greater than the hydrothecal depth. Branches upwards directed, parallel with the stem.

Hydrotheca deeply campanulate, expanding slightly to margin, delicate, often with straight abcauline wall and slightly convex adcauline one. Depth usually 1.5–2 times diameter. Margin with 10–12 pointed cusps of variable length, each with a distinct 'keel' or stiffening strip, visible as a longitudinal ridge extending from the cusp tip a short way down the theca. Cusps separated by rounded bays. Diaphragm delicate, distinct; transverse or slightly oblique.

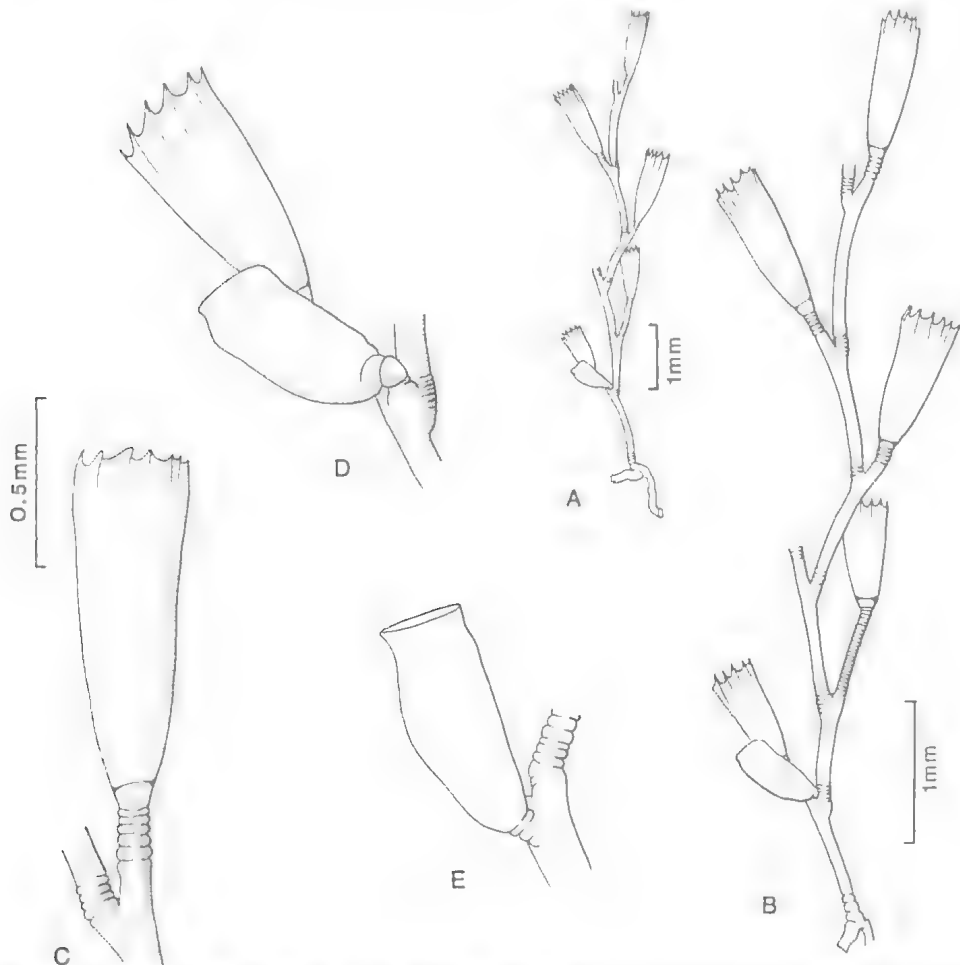


FIG. 22. *Clytia linearis* (QM GL10205). A, B, part of sympodium; C, hydrotheca; D, hydrotheca and gonotheca; E, gonotheca. Suva Barrier reef.

Gonotheca borne at base of hydrothecal pedicel; on a short, annulated pedicel; smooth, tapering proximad and truncated distally.

MEASUREMENTS (μm)

Hydrotheca: depth 550–700; marginal diameter 300–400. Gonotheca: length 600; marginal diameter 170; maximum diameter 280.

VARIATIONS

Occasional second order, sympodial branches may be present (Fig. 22). Marginal renovation common. Annulations below hydrothecae rarely interrupted by a smooth mid-region.

OCCURRENCE IN FIJI

Thangilai reef, 28 Apr. 78 (reproductive); Suva barrier reef, boulder zone, 27 Apr. 79 (QM GL10205); forereef west of Suva Point, 0–20 m, 19 Feb. 80; all on coral rock.

WORLD DISTRIBUTION

Tropical, subtropical and warm temperate oceans.

Obelia Péron and Lesueur, 1810

Obelia bidentata Clarke, 1875

(Fig. 23)

Obelia bidentata Clarke, 1875: 58

Obelia bidentata Clarke, 1875: Cornelius 1975: 260 (cum syn.)

DESCRIPTION

Colonies erect; stems monosiphonic, unbranched; slightly geniculate in younger regions only; reaching 11 mm. Hydrothecae alternate, sympodial. Internodes of variable thickness, with four or more annulations at the proximal end and bearing hydrotheca on short apophysis distally. Pedicel short, typically less than half hydrothecal depth; closely annulated throughout.

Hydrotheca elongate-campanulate, circular in cross section, delicate. Depth 2.5–3 times diameter. Margin with 10–14 bimucronate cusps; 'keel' absent. Diaphragm delicate, indistinct; transverse or slightly oblique.

Gonotheca arising either in axil of hydrothecal pedicel or directly from hydrorhiza; supported by

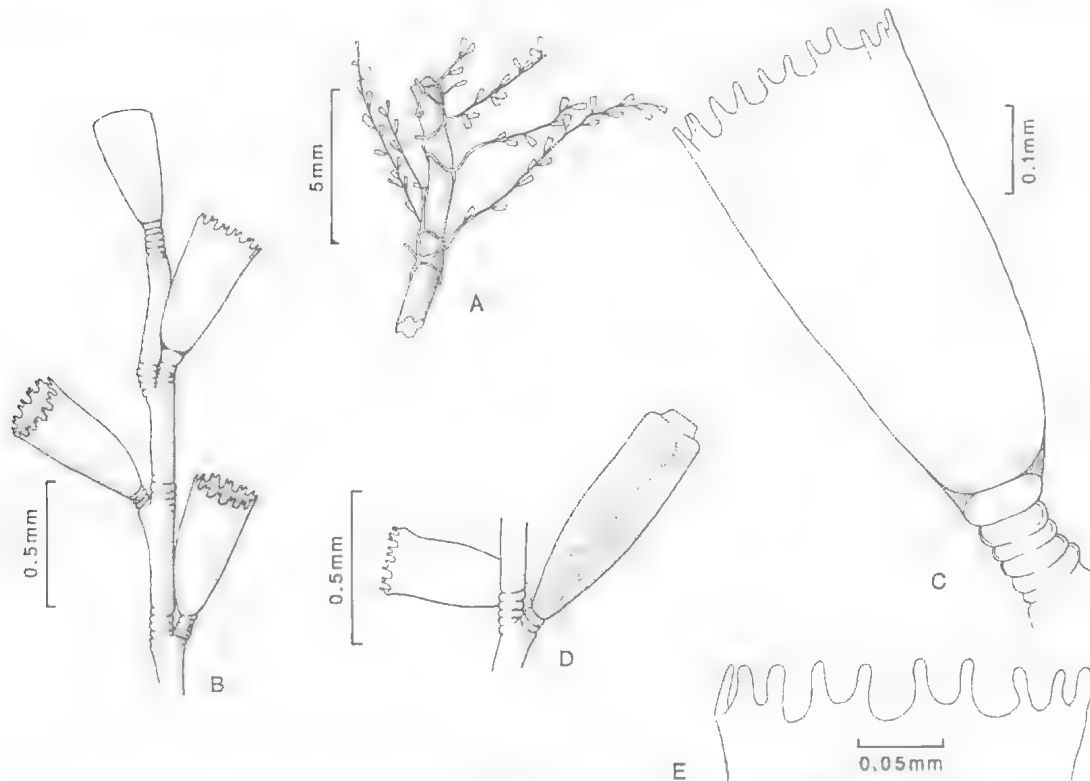


FIG. 23. *Obelia bidentata* (QM GL10206, 10241). A, part of colony growing on *Gracilaria*; B, portion of stem; C, hydrotheca; D, gonotheca; E, rim of hydrotheca showing bicuspid teeth. Mba.

short, annulated pedicels; smooth, elongated, tapering proximad and truncated distally. Aperture borne on a short but distinct collar.

MEASUREMENTS (μm)

Hydrotheca: depth 550–650; marginal diameter 220–280. Gonotheca: length 640–870; marginal diameter 90–120; widest diameter 190–240.

VARIATIONS

The hydrothecal pedicel is variable in length, usually, though not always, less than half the thecal depth. Some hydrothecae have slightly keeled cusps and several longitudinal ridges.

REMARKS

Our material resembles *O. oxydentata* Stechow, 1914, as illustrated by Hirohito (1969), later referred to *O. bidentata* by Cornelius (1982). The gonothecal aperture is on a distinct collar, the hydrothecal pedicels are relatively short, and the colony shows little branching. Although these are characters displayed by *O. oxydentata* they fall within the range of variation of *O. bidentata* (Cornelius, 1975 and pers. comm.)

OCCURRENCE IN FIJI

On *Gracilaria*, intertidal sand flats near mouth of Mba river, 9 Nov. 78 (reproductive) (BM 1984.5.17.10; QM GL10206).

WORLD DISTRIBUTION

Widespread in temperate to tropical seas.

***Campanularia* Lamarck, 1816**
***Campanularia* sp. (Fig. 24)**

DESCRIPTION

Colony stolonial. Pedicels unbranched, variable in height, reaching 2.4 mm; corrugation variable throughout, but bearing distally a depressed spherule which often has one or more partial or complete annuli immediately below it. Without basal annulations.

Hydrothecae of variable shape, deeply campanulate, expanding to margin or not, often with an indistinct submarginal ridge or rim; depth variable, usually 1.5–3.5 times marginal diameter. 10–14 marginal cusps; obtusely pointed and variable in height, separated by rounded bays. Annular perisarc thickening apparently constant in position, distinct and separating off a small, basal chamber, rectangular in side view. Wall



FIG. 24. *Campanularia* sp. (QM GL10207). Portions of hydrothecae showing variations in pedicel length and annulation; renovation of hydrotheca in B. Ndeumba.

thickened to a variable degree, but never so much as in *Orthopyxis integra* (MacGillivray, 1842). Gonothecae not observed.

MEASUREMENTS (μm)

Hydrotheca: depth 200–800; marginal diameter 140–230.

VARIATIONS

Pedicel always with distinct corrugations at the base, but thereafter they may be indistinct, close, or even spiral. Spherule typically depressed, but may be globular. Cusps likewise varying in shape and size: tall, thin and pointed, or short, broad and rounded, with the accompanying intermediates. Margin showing several renovations in some specimens.

REMARKS

This material differs from *Campanularia crenata* Allman, 1876, by the hydrotheca having no basal bulge, not flaring to margin, and lacking longitudinal striations leading from the cusps. It differs from *Orthopyxis crenata* (Hartlaub, 1901b) especially in cusp shape. Both of these species have types which came from the boundary area between the Indian and Pacific Oceans and might, therefore, be expected to occur in Fiji.

There are similarities with *C. africana* Stechow, 1923, but examination of the type in the South African Museum showed it to be distinct. Our material is also close to *C. morgansi* Millard, 1957, but again there are differences. In the absence of gonothecae we cannot identify our specimens with any described species.

OCCURRENCE IN FIJI

On red alga (? *Laurencia*), Ndeumba fringing reef, 8 Jul. 79 (QM GL10207).

Family SERTULARIIDAE

Calamphora Allman, 1888*Calamphora campanulata* (Warren, 1908)

(Fig. 25)

Sertularella campanulata Warren, 1908: 300

Calamphora campanulata (Warren): Mammen 1965: 35

Calamphora campanulata (Warren, 1908): Millard 1975: 253

DESCRIPTION

Colony stolonial. Hydrotheca solitary, pedicellate; terminal, barrel-shaped, tall, widest in mid-region; with up to 10 transverse annulations or ridges. Margin with four pointed cusps; often showing renovation; four triangular opercular valves. Height of pedicel usually less than depth of hydrotheca, twisted spirally or with corrugations. Gonothecae not observed: similar to hydrothecae but of wider, bulging shape (see Mammen (1965) for further description).

MEASUREMENTS (μm)

Hydrotheca: length 770–960; marginal diameter 270–330.

VARIATIONS AND REMARKS

Most previous records of this species have been on algae: this was growing over coral rock. Both the hydrothecae and pedicels are longer than described by Mammen (1965) and Millard (1975), though not as long as in *Sertularella solitaria* Nutting, 1904, which we would refer to *Calamphora*. While pedicel length may well be variable, there seem at present no firm grounds for merging *C. campanulata* with *C. solitaria*, especially since Nutting's material was infertile. Otherwise this species is close to *C. parvula* Allman, 1888. Mammen (1965: 35, fig. 67, as *Campanularia*) recorded *C. campanulata* from southern India, and described gonothecae which closely resemble those of *C. parvula* as described by Allman (1888) from Australia. These two nominal species may prove conspecific.

Vervoort (1968, 1972), following Hartlaub (1901a), placed *C. parvula* in the genus *Sertularella*, seeing no reason to retain *Calamphora* for species of *Sertularella* 'that have separate hydrothecae arising from their hydrorhiza, besides normally built colonies'. In fact, *all* the hydrothecae arise from the hydrorhiza in the three species described, and Millard (1975), for example, retained *Calamphora* for such purely stolonial forms. (*Sertularella parvula* Mammen, 1965, is an entirely different, erect species).

OCCURRENCE IN FIJI

Joske's reef, 18 Sep. 78 (QM GL10208).

WORLD DISTRIBUTION

South Africa (Natal), Madagascar, India, Indo-China, Japan and Australia.

Diphasia L. Agassiz, 1862*Diphasia orientalis* Billard, 1920

(Fig. 26)

Diphasia orientalis Billard, 1920: 146

D. orientalis: Billard 1925: 212

DESCRIPTION

Colony erect. Stems stiff, monosiphonic and unbranched, reaching 8 mm. Hinge joints, of which there may be more than one, occur only to terminate the basal, athecate part of the stem, which is of variable length and often subdivided proximally by one or more transverse nodes.

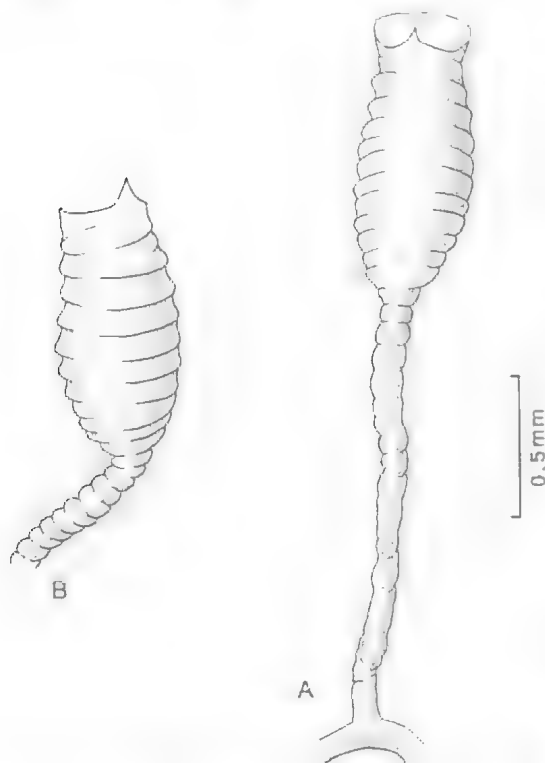


FIG. 25. *Calamphora campanulata*. Hydrothecae. QM GL10208, Joske's reef.

Remaining nodes slightly oblique and indistinct. Each internode bearing one pair of lateral hydrothecae, consecutive pairs well separated.

Hydrothecae opposite, most pairs not contiguous; adnate to stem for most of vertical height, pentagonally tubular (the angles ridged), widening gently to margin; free portions diverging from stem at 60–85°; abcauline side the longer; adcauline side slightly thickened. No marginal or internal cusps; one large adcauline opercular valve. Gonothecha not observed, but described by Billard (1925): inserted below hydrotheca, one per internode, to form a single row extending two-thirds up stem length. Male with numerous spines, these often laterally flattened and drawn out to form longitudinal ridges. Distalmost spines surrounding a small, circular aperture and a short

collar. Female pyriform, with a broad chamber and three large valves terminating in a point distally; two broad lateral blades.

MEASUREMENTS (μm)

Measurements from Billard (1925) in parentheses. Hydrotheca: marginal diameter 160–190 (180–215); free adcauline length 110–200 (310–430); adnate adcauline length: 420–550 (530–760); abcauline length 450–620. Gonothecha (male): length (1000–1070); width (410–460). Gonothecha (female): length (1230–1540); width (575–655).

VARIATIONS

Hydrothecae become closer together distad and may even be contiguous in front (though still separate behind): angle of divergence decreases distad.

REMARKS

The Fijian specimens were smaller than those described by Billard (see 'Measurements').

OCCURRENCE IN FIJI

Forereef, 0–20 m, west of Suva Point, on coral rock, 19 Feb. 80 (QM GL10209).

WORLD DISTRIBUTION

Only previous record: Malay Archipelago, several localities (Billard, 1925).

Dynamena Lamouroux, 1812
***Dynamena cornicina* McCrady, 1857**
 (Fig. 27)

Dynamena cornicina McCrady, 1857: 102
D. cornicina McCrady, 1858: Millard, 1975: 261

DESCRIPTION

Colony comprising hydrorhiza bearing erect stems; these thick but not polysiphonic, typically unbranched but pinnate with alternately arranged hydrocladia; reaching 65 mm; divided by slightly oblique nodes into regular thecate internodes, each bearing a hydrocladial apophysis near the base and three cauline hydrothecae; basal internode short and athecate, terminated by a transverse node; hinge joints absent. Apophyses short, terminated by a transverse node. Hydrocladia with a variable number of athecate internodes proximally, with oblique, hinge-type nodes. All distal internodes thecate, with regular, transverse nodes. Each internode with one pair of opposite hydrothecae, these contiguous in front and separate behind.

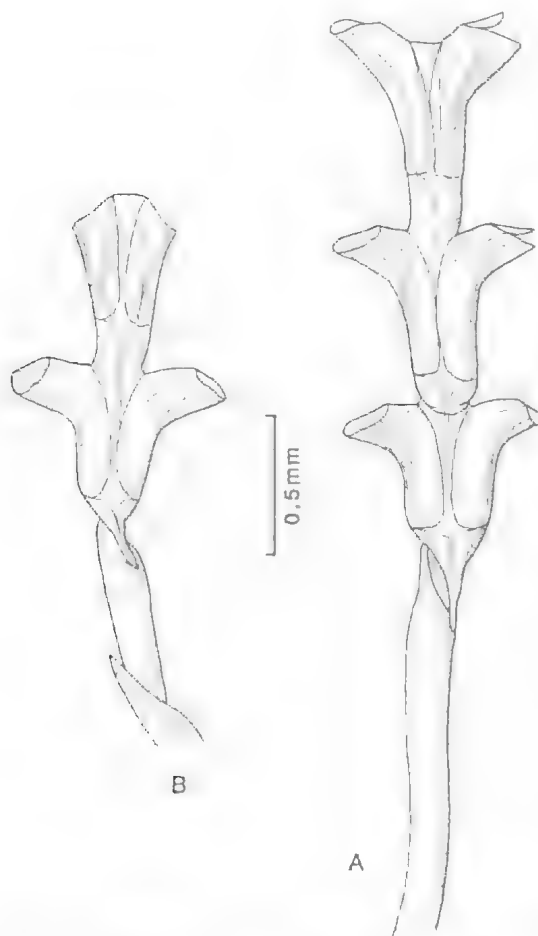


FIG. 26. *Diphasia orientalis*. Parts of stems showing hinge joints near base and hydrothecae. QM GL10209, Suva Barrier reef.

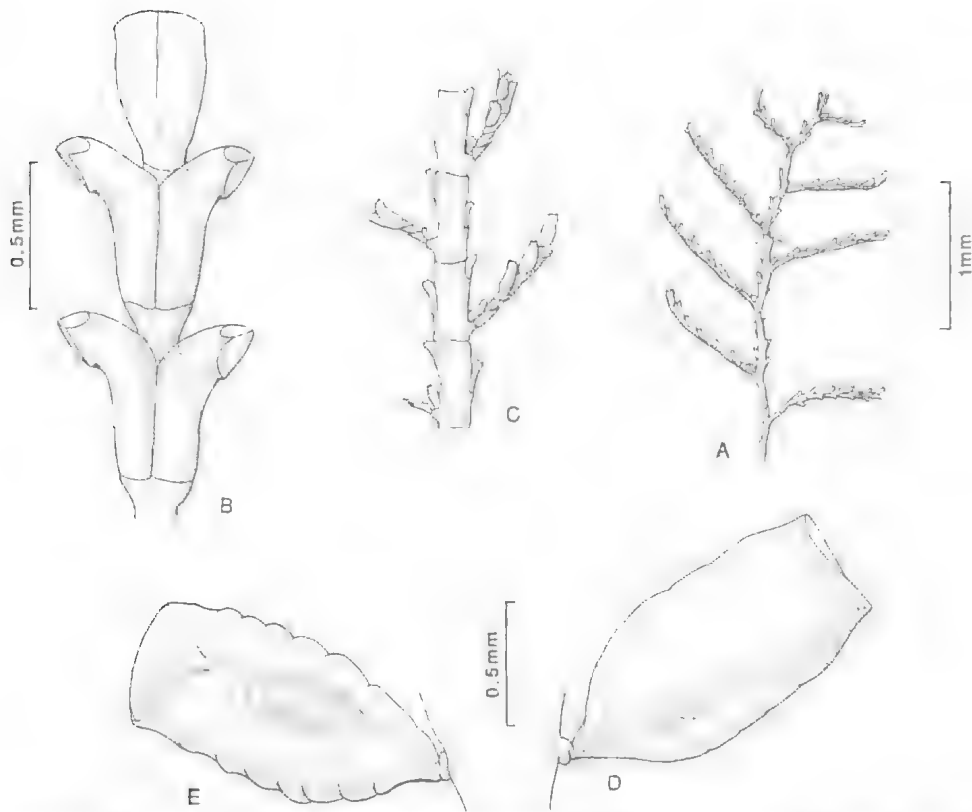


FIG. 27. *Dynamena cornicina*. A, part of colony (QM GL10210); B, part of hydrocladium with hydrothecae; C, stem internodes (B-C, QM GL10212); D, E, gonothecae (QM GL10210/11; Frigate Passage).

Hydrothecae tubular, walls more or less parallel with the stem proximally; then outcurving gradually and evenly to the margin; narrowing little. Adnate for more than three-quarters vertical height, with free adcauline wall at $60\text{--}70^\circ$ to stem. No intrathecal septum. Margin with two, pointed lateral cusps displaced slightly to the adcauline edge; also one large adcauline cusp, extending as far out as the laterals; and one small abcauline internal cusp. Hydrothecal base distinctive, waistcoat-like.

Gonotheca borne on stem, occupying position of apparently damaged cauline hydrotheca (rarely the axial hydrotheca, however); elongate barrel-shaped, distinctly annulated, with broad distal aperture supported by a short collar.

MEASUREMENTS (μm)

Hydrotheca: adnate adcauline length 400–480; free adcauline length 160–240; contiguous adcauline length 340–430; marginal diameter 170–185. Stem (thecate) internode length: 1050–1260. Hydrocladial internode length: 550–650.

Gonotheca (Philippines material included): length 1188–540; marginal diameter 468–540.

VARIATIONS

Sporadically along the stem are sometimes found: (a) very short athecate internodes without apophyses; (b) internodes without an apophysis but with up to two pairs of subopposite hydrothecae. Hydrothecae delicate, liable to damage: they become more erect and adnate distad, where the angle of divergence decreases. Unlike most other members of this genus, *D. cornicina* does not have grouped hydrothecae, except on the stem. However, it would not easily be confused with branched *Sertularia* species, for example *S. marginata* (Kirchenpauer, 1864) which, being circumtropical, is quite likely to be found around Fiji, owing to the lack of an abcauline caecum.

OCCURRENCE IN FIJI

Widely distributed on sublittoral coral rock up to about LWST. Ndeumba (with *Hebella scandens*), 18 Mar. 79, with gonothecae (BM

1984.5.17.22; QM GL10210); forereef slope, 14 m, off Suva Point, 3 Apr. 79, with gonothecae; Yanutha reef, 0–20 m, 7 Oct. 79 and Frigate Pass 3–8 m, 2 Nov. 79 (QM GL10212); Mbengga barrier reef, 2 Nov. 79 (BM 1984.5.17.21, 23); below the buttresses at mouth of Makuluva Pass, 15–20 m, 2 May 80. The localities represent a range of conditions from the high energy situation off Suva Point to the shelter of Mbengga leeward reef. Also Verde Rocks, San Agapito Point, Verde I., Philippines, 24 May 81 (QM GL10211).

WORLD DISTRIBUTION

Cosmopolitan in warm waters.

Dynamena crisioides Lamouroux, 1824 (Fig. 28)

Dynamena crisioides Lamouroux, 1824: 613

D. crisioides Lamouroux, 1824: Millard, 1975: 263

D. crisioides var. *gigantea* [in part] Billard 1924: 651

DESCRIPTION

Colony comprising hydrorhiza bearing erect, monosiphonic, straight or slightly geniculate stems, reaching 55 mm; hydrocladia alternate. Stem with short basal part lacking hydrocladia but with one pair of subopposite hydrothecae, terminated by an oblique node; then divided by slightly

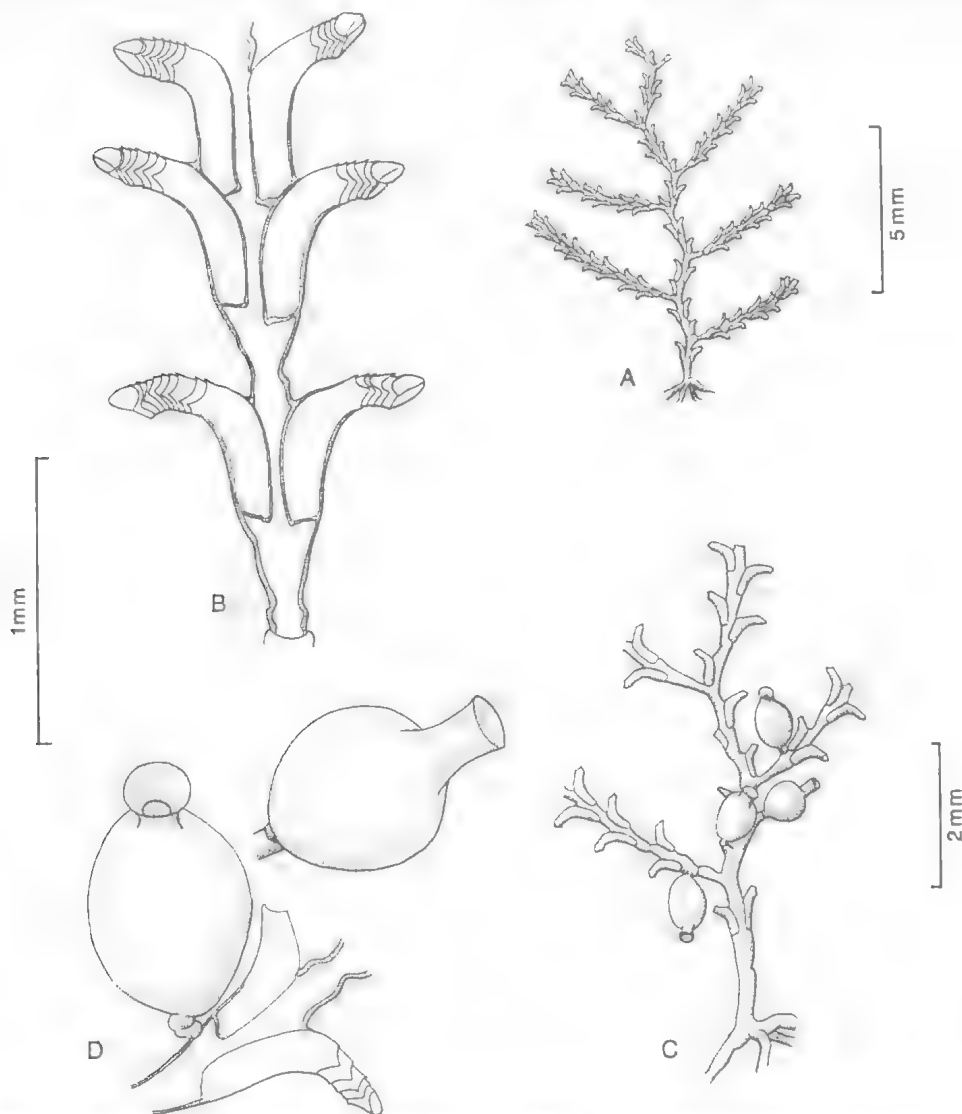


FIG. 28. *Dynamena crisioides*. A, Part of colony (QM GL10213); B, part of hydrocladium with hydrothecae (QM GL 10215, Mba); C, part of colony with gonothecae; D, gonothecae (QM GL 10214, Suva Barrier Reef).

oblique nodes into regular internodes, each with a long hydrocladial apophysis near base and subsequently one axillary and two subopposite hydrothecae. The apophysis may be divided by a transverse node. Hydrocladia divided by slightly oblique nodes into irregularly-spaced internodes bearing a variable number of subopposite hydrothecae; consecutive pairs may overlap. Members of a pair never contiguous in front.

Hydrothecae on sides of stem and hydrocladia, tubular, adnate for more than half vertical height, then outcurved. Angle of adcauline wall with the stem axis variable, 65–80°, with an angular shoulder at the point of adnate divergence, sometimes concealed by the overlap from the next hydrotheca. Intrathecal septum absent. Margin with two pointed lateral cusps, displaced slightly to the abcauline edge, and one smaller adcauline cusp. Abcauline thecal wall thickened; internal cusp absent.

Gonothecae arising from stem or hydrocladia; on former from within hydrothecae and on the latter from below the first pair of hydrothecae. Smooth, ovoid and with an operculate aperture on a long forward-curved neck.

MEASUREMENTS (μm)

Measurements for normal form and var. *gigantea* respectively. Hydrotheca: adnate length 380–540, 522–666; free adcauline length 120–500, 72–360; marginal diameter 130–220, 144–180. Stem internode length: 700–1500, 2100–2700. Hydrocladial internode length: 1080–1350, 2100–3400. Gonotheca: length 900–1800, —; maximum diameter 540–720, —; marginal diameter 198–252, —.

VARIATIONS

This has long been recognized as a very variable species, and two forms have been found in Fiji: the normal, <20 mm high, with the stem distinctly geniculate and having up to three pairs of hydrothecae per hydrocladial internode; and var. *gigantea* Billard (1924), taller, with a straight stem and up to six pairs of hydrothecae per hydrocladial internode. Number of apophyses and hydrothecae per cauline internode variable, even zero. Renovation of hydrothecal margin common, often leading to considerable extension. Hydrocladial branching rare. Tendrils resembling hydrorhizae often arise from the ends of hydrocladis or stem and may then insert elsewhere in the colony.

OCCURRENCE IN FIJI

Common and widely distributed; the only

hydroid to occur on coral boulders that endure long emersion. Many records from Suva barrier reef (BM 1984.5.17.16; QM GL10214); also on *Sargassum* in the backreef lagoon (Naseke, Suva), Ndeumba (QM GL10213) and on the flats of Yarawa (BM 1984.5.17.17; QM GL10215), Tailevu Point (BM 1984.5.17.18) and Vunda. *Hebella scandens* (frequently) and *Clytia hemisphaerica* occur on it. *D. crisioides* was also collected on the windward reef at Tanaea, Tarawa atoll, Kiribati, 11 Feb. 79 (BM 1984.5.17.19), and from London pier, Christmas I. (Line group), bearing both *H. scandens* and *C. hemisphaerica*, 16 Feb. 79. The var. *gigantea* was from Yarawa reef (BM 1984.5.17.20; QM GL10216).

WORLD DISTRIBUTION

Warm water cosmopolitan.

Dynamena quadridentata (Ellis and Solander, 1786) (Figs. 29, 30)

Sertularia quadridentata Ellis and Solander, 1786: 57
Dynamena quadridentata (Ellis and Solander, 1786):
Millard 1975: 266 (cum syn.).

Two forms of this species were found in Fiji: we refer to them as 'A' and 'B'.

DESCRIPTION OF FORM 'A' (Fig. 29)

Colony comprising erect, unbranched stems arising from the hydrorhiza. Hydrorhiza broad, with regular internal perisarcular pegs. Stems monosiphonic, unbranched, reaching 2 mm. Basal athecate portion short, terminated by a hinge joint; subsequent internodes thecate with very oblique, hinge-like nodes. Hydrothecae in groups or in separated pairs, members of any pair contiguous in front, separate behind. Stems with never more than three internodes, basal one(s) with a pair of hydrothecae, distal one with groups.

Structure of hydrothecae varying according to whether they comprise single pairs or groups, and further influenced by position within the group. For *hydrothecae in single pairs*: abcauline wall more or less parallel with stem axis before turning gradually up and out, but slightly swollen at the base and again just above; adnate for more than three-quarters vertical height, and members of a pair contiguous for most of that; free adcauline wall at 60–75° to stem. For *grouped hydrothecae*: adnate for nearly entire vertical height, considerable overlap between consecutive pairs of hydrothecae; contiguity between members of pair

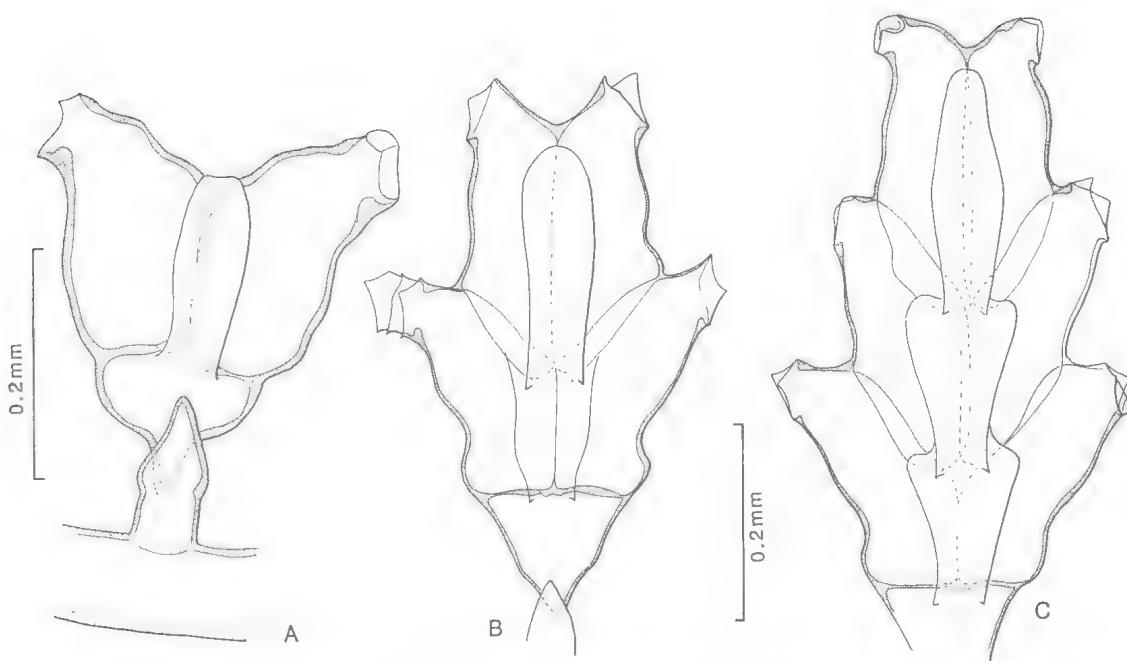


FIG. 29. *Dynamenella quadridentata* (Type A). A, basal internode with pair of hydrothecae; B, distal internode with two pairs of hydrothecae; C, distal internode with three pairs of hydrothecae. (QM GL 10217). Ndeumba.

increasing distad, non-contiguous part of adnate adcauline wall sigmoidal, free part short, angle of free adcauline wall to stem axis approximately 90° , but decreasing distad; proximal pair with basal and mid-region swellings on abcauline wall.

All hydrothecae with thickened ad- and abcauline walls, without intra-thecal septa. Margin narrow, with three cusps: one adcauline, small, and two midlateral, triangular; also two relatively large internal cusps, ad- and abcauline.

Gonotheca not observed; see Millard (1975) for description.

VARIATIONS

The basal thecate internode may frequently have grouped hydrothecae, but the number per group increases distad. Margin renovation is common. Lateral cusps may show asymmetry. A small abcauline marginal cusp sometimes apparent but actually an extension of abcauline internal cusp.

DESCRIPTION OF FORM 'B' (Fig. 30)

More or less as 'A' but reaching 5 mm. Hydrorhiza lacking internal perisarcal pegs. Stem nodes much more indistinct, with hinge joints occurring sporadically. All stems with several single hydrothecal pairs basally and one or two groups distally. Hydrothecae in single pairs, lacking the two abcauline swellings of 'A', smooth and evenly

concave; adnate for nearly entire vertical height, then bent out at approximately 90° ; sometimes grossly enlarged, up to 2.5 times normal. Grouped hydrothecae not overlapping to the same degree as in 'A'; the adnate, non-contiguous part of adcauline wall not sigmoidal. Free portion of adcauline wall much longer than in 'A'. Margin with three cusps, one adcauline, small, and two lateral, well developed; laterals may again be asymmetrical and a fourth, abcauline cusp illusory; internal cusps prominent and large; margin renovation common. Gonotheca borne on the stem below the first pair of hydrothecae: barrel-shaped with five shallow annulations; distal aperture broad and raised.

MEASUREMENTS

See Table 1.

REMARKS

The two forms of *D. quadridentata* from around Fiji are very different in appearance. However, such variation is well documented, as evidenced by the number of described varieties (see Billard, 1925; Millard, 1975). Form 'A' resembles the 'classical' *D. quadridentata* (see Billard, 1925) while form 'B' agrees with Millard's (1958) material and account of *D. quadridentata* var. *nodosa* Hargitt, 1908. It also resembles *D. heter-*

TABLE 1. Measurements of *Dynamena quadridentata* and *D. heterodonta* from various sources: *D. quadridentata*, Fiji, forms 'A' and 'B'; 1, *D. quadridentata* var. *nodosa*, Caribbean (van Gernerden-Hoogaveen, 1965); 2-4, *D. heterodonta*; 2, French Polynesia (Vervoort and Vasseur, 1977); 3, Indian Ocean (Cargados Garajos), BM 1923.2.15.146; 4, as 3, BM 1923.2.15.152.

MEASUREMENTS (μm)	FORM A	FORM B	1	2	3	4
Hydrothecae: vertical height	215-315	200-290	200-320	230-265		
marginal diameter	60-75	75-85	60-110	80-95	65-75	65-80
adnate adcauline length	200-270	200-305	200-300	135-190	200-265	215-225
free adcauline length	50-110	75-170	140-235	200-270	60-90	120-150
contiguous adcauline length	105-230	90-180	75-175		100-240	100-160
Internode length		325-900	440-1250			475-720
Gonothecae: height		936-1044				
marginal diameter		306-450				

odonta (Jarvis, 1922). Despite the acknowledged similarity of *D. heterodonta* with *D. quadridentata*, and Vannucci's (1951) placement of the former as a variety of the latter, the species *heterodonta* persists in the literature. While we cannot here resolve the issue, we question the independent validity of *heterodonta*.

D. quadridentata and *D. heterodonta* have been separated by:

(1) The presence of internal perisarcal pegs in the

hydrorhiza of *D. quadridentata* (Billard, 1925; present observations) absent from *D. heterodonta* (Jarvis 1922, Type BM 1923.2.15.146).

(2) The free portion of the hydrotheca is relatively longer in *D. heterodonta* (Billard, 1925; Vervoort and Vasseur, 1977).

(3) A fourth, abcauline marginal cusp has been reported in *D. heterodonta* (Vervoort and Vasseur, 1977).

(4) The lateral cusps of *D. heterodonta* are

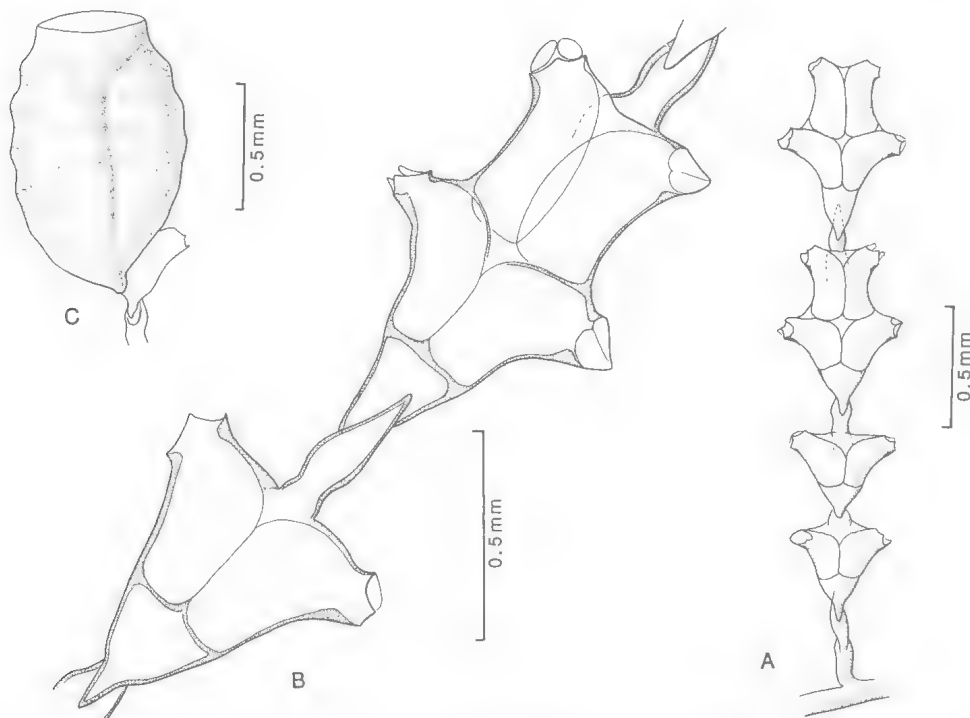


FIG. 30. *Dynamena quadridentata* (Type B). A, portion of colony; B, stem internodes with one and two pairs of hydrothecae; C, gonotheca. (QM GL10218) Ndeumba.

unequally developed, leading to the formation of an opercular cone (Vervoort and Vasseur, 1977) which is absent in *quadridentata*.

There is evidence suggesting that the supposed differences between the two nominal species do not exceed the range of variation of *D. quadridentata*. Thus:

(1) *D. quadridentata* has been recorded both with and without perisarcal pegs in the hydrothiza (cf. Billard, 1925 and Vervoort, 1968).

(2) 'Long' free portions of the hydrotheca have been noted by Millard (1958) in *D. quadridentata* var. *nodosa*, while 'short' free portions are evident in some hydrothecae on the type specimen of *D. heterodonta*. The latter species displays a tendency to margin renovation and, hence, to lengthening of the free portion. If the renovations are ignored, much of the length difference disappears. Margin renovation, moreover, does occur in *D. quadridentata* s. str. (present observations).

(3) The abcauline marginal tooth in Vervoort and Vasseur's description of *D. heterodonta* is not a feature of the type. What appears to be a cusp is actually an extension or renovation of the abcauline internal cusp. Internal cusps are known to be variably developed in *D. quadridentata* (Millard, 1975).

(4) Examination of material referred to *D. quadridentata* in the South African Museum reveals rare instances of unequally developed marginal cusps, such that small opercular cones appear. Contrariwise, not all hydrothecae of the type specimen of *D. heterodonta* display this cone.

The gonothecae of both nominal species are barrel-shaped and annulated, with 4-8 annulations in *D. quadridentata* (Billard, 1925; Millard, 1958; Vervoort, 1968) and 5-6 in *D. heterodonta* (Jarvis, 1922; Vannucci, 1951; Vervoort and Vasseur, 1977).

While the arguments for not merging *D. heterodonta* with *quadridentata* are perhaps subjective, we are reluctant to do so for the following reasons: (1) Ellis and Solander's type material has almost certainly been lost, and we can find no evidence of any subsequent author having made direct observations on the type.

(2) The obvious opercular cone of *D. heterodonta* is at most weakly produced in *D. quadridentata*. This may, of course, be environmentally induced, but until stronger evidence can be provided, we feel that it is a character which should not be ignored.

The absence of such a cone in the Fijian material causes us to treat it as *D. quadridentata*.

OCCURRENCE IN FIJI

Form A: Usually on algae, often associated with encrusting sponges. Among *D. crisioides* and sponge on coral rubble, Suva barrier reef flat, 25 Jul. 78 and in sponge, Ndeumba fringing reef, 20 Aug. 78 (QM GL10217). Form B: On red algae, with small form of *Hebella scandens*, Ndeumba, 8 Jul. 79 (QM GL10218); on coral rock, Great Astrolabe reef, 12 Jul. 80.

WORLD DISTRIBUTION

Circumglobal in warm temperate and tropical waters.

Salacia Lamouroux, 1816

Salacia tetracythara Lamouroux, 1816
(Fig. 31)

Salacia tetracythara Lamouroux, 1816: 212

S. tetracythara Lamouroux: Billard 1925: 202

DESCRIPTION

Colony erect; stems moderately stiff, reaching 30 mm; polysiphonic in lower parts and usually unbranched; bearing alternate hydrocladia; divided by regular oblique nodes into thecate internodes each bearing a hydrocladial apophysis and three cauline hydrothecae, inferior, axillary, and opposite; apophysis short, with an oblique node.

Hydrocladia branching at a wide angle to the stem, usually 75-90°, and in the same plane; slightly narrower than the stem; nodes distinct and slightly oblique; internodes of variable length, with an inconstant number of subopposite hydrothecae. Hydrothecae on the sides of the hydrocladia, in overlapping pairs, not contiguous; tubular, adnate for almost entire length, outcurved distally and narrowing a little to margin; abcauline wall thickened and more or less parallel with hydrocladial axis throughout. Intrathecal septum absent. Margin delicate, often showing signs of renovation; with three marginal cusps, two obscure laterals and one large pointed abcauline; also a single abcauline internal cusp.

An inconstant number of gonothecae borne proximally on hydrocladia, below hydrothecae; barrel-shaped, smooth; aperture distal, broad, on a short collar, surrounded by a thin ridge.

MEASUREMENTS (µm)

Hydrotheca: marginal diameter 130-140; adnate abcauline length 400-550; free abcauline length 310-350; abcauline length 65-105. Gonotheca: length 882-1134; marginal diameter 396-558.

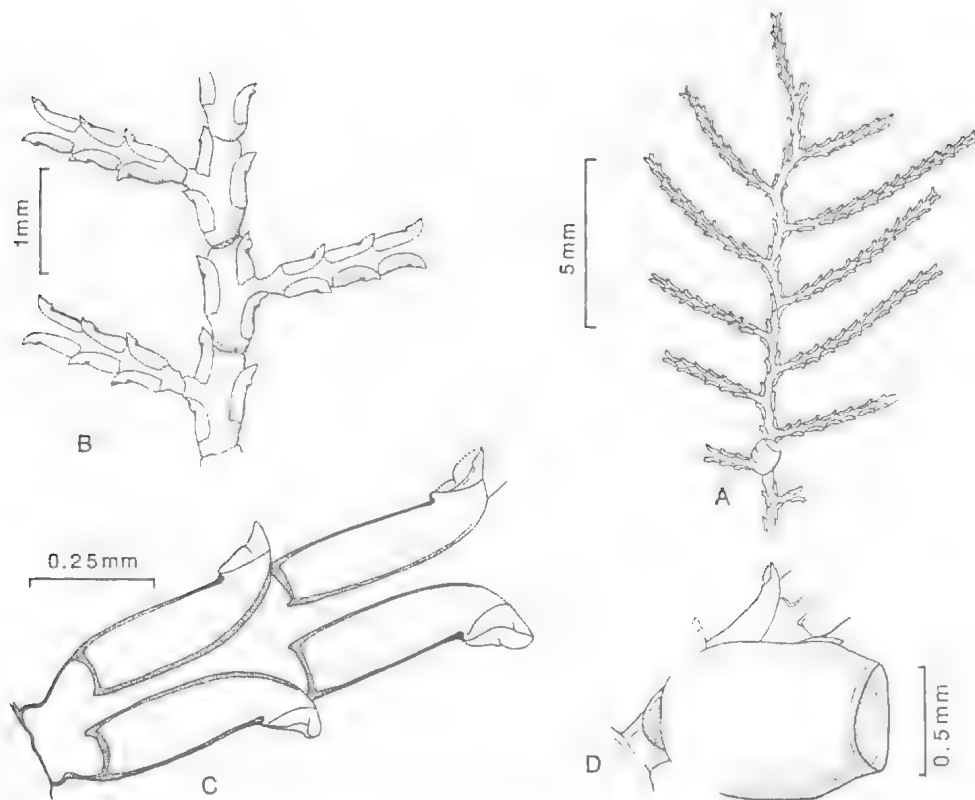


FIG. 31. *Salacia tetracythara*. A, part of colony; B, part of stem; C, hydrothecae (QM GL10220, Suva barrier reef); D, gonotheca (QM GL10219, Ndeumba).

VARIATIONS

Stem polysiphonic only near the base, with hydrocladia arising from both axial and peripheral tubes. Hydrocladial branching rare, and only if the hydrocladium itself is polysiphonic: the two resultant hydrocladia in different planes. Apical tendrils common. Typically three cauline hydrothecae per stem internode, occasionally one subopposite pair and no hydrocladial apophysis. More than one gonotheca may arise from the same place.

OCCURRENCE IN FIJI

At LWST on coral rock, Suva barrier reef, 29 Mar. 79 (QM GL10220), Ndeumba fringing reef, 20 Aug. 78 (QM GL10219), 18 Mar. 79, 8 Jul. 79, and windward Great Astrolabe reef, 12 Jul. 80; 3–8 m in Frigate Pass, Mbengga leeward barrier reef, 2 Nov. 79. Reproductive in July, August and November.

WORLD DISTRIBUTION

India, Malay Archipelago, Queensland.

Sertularella Gray, 1848

Sertularella diaphana (Allman, 1886)

(Fig. 32)

Thuiaria diaphana Allman, 1886: 145

Sertularella diaphana (Allman): Billard 1925: 157

Sertularella diaphana (Allman, 1886): Millard 1975: 285

This species occurs in Fijian waters in two varieties, the typical form and var. *delicata* Billard (1925), which display same general colony structure but differ in size and points of micro-structure.

DESCRIPTION

Colonies variable; stems generally unbranched, pinnate, with alternate hydrocladia in one plane; divided into regular internodes by nodes which slope alternately right and left. Stem internodes with a short hydrocladial apophysis in the upper half and three hydrothecae: inferior, subopposite,

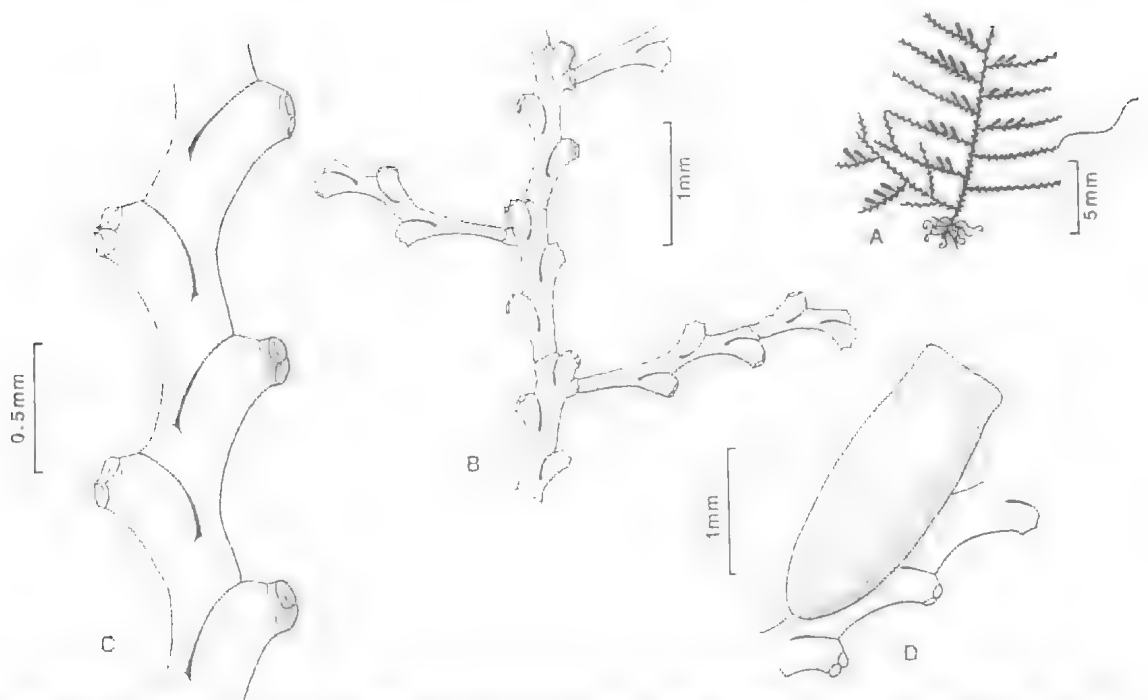


FIG. 32. *Sertularella diaphana*. A, habit; B, part of stem and hydrocladia (var. *delicata*, QM GL10222, Great Astrolabe Reef); C, hydrothecae; D, gonotheca (QM GL10221, Makuluva Pass).

and axillary. Hydrocladia divided into internodes by sloping nodes as in the stem.

Hydrothecae on the lateral surfaces of stem and hydrocladia, nearly completely adnate, smooth and outcurved: abcauline wall variably concave; free portion of adcauline wall straight, short, and at 90–100° to the stem. Margin with four low cusps, thickened. In var. *delicata* hydrothecae also arising direct from the hydrorhiza.

Gonothecae observed in the typical form only: borne below the hydrothecae on the anterior surface of the hydrocladium; elongated, tapering proximad and truncated distally; with a variable number of distinct longitudinal ridges.

MEASUREMENTS (μm)

Measurements for typical form and var. *delicata* respectively. Stem: internode length 1250–1500, 1000–1350; width 510–690, 170–260. Hydrocladia: internode length 3000–4700, 1000–1450; width 230–340, 140–180. Hydrotheca: adcauline adnate length 425–500, 215–290; adcauline length 75–125, 40–110; marginal diameter 150–180, 150–175. Gonotheca: length 2142–2474, —; marginal diameter 657–756, —.

VARIATIONS AND REMARKS

The stem in the typical form tends to be stiff,

thick, and polysiphonic, especially basally, reaching a height of 80 mm. The hydrocladial (as opposed to stem) internodes are of variable length, with the number of hydrothecae correspondingly inconstant. In var. *delicata*, in contrast, the stem is flexible, thin, monosiphonic, slightly geniculate and attains a height of only 15 mm. It is also sometimes epizoic. Such differences could not be the result of age, even though short colonies of the typical form are known to be epizoic, since these are usually polysiphonic basally. We agree with Billard that the two can be separated by size (see 'Measurements'), stem structure, and degree of curvature of the adcauline hydrothecal wall (that of var. *delicata* being the more recurved at the base, thereby restricting communication with the stem or hydrocladium). However, our material does not conform with his statement that the free part of the adcauline thecal wall is longer in *delicata* than in the typical form (indeed, if one examines Billard's (1925) figures of the two varieties, the difference appears almost non-existent for the latter). The two varieties from Fiji are similar in this respect. This character is obviously inconsistent. Another feature by which our specimens in the two forms differ is the degree of concavity of the abcauline hydrothecal wall, which is more even, smooth and predictable in var.

delicata, though the typical form shows a greater tendency to thicken the adcauline wall unevenly at the base. We have not recorded var. *gigantea* Billard (1925).

S. diaphana might also be confused with *S. decipiens* Billard, 1919, which has the same hydrothecal shape with a short but distinct free adcauline wall, but also has a pronounced abcauline internal cusp and a complete hydrothecal base.

OCCURRENCE IN FIJI

The typical form found below the buttresses, Makuluva reef (seaward end of the Pass), 15–20 m, reproductive, 2 May 80 (BM 1984.5.17.34; QM GL10221). Var. *delicata* was on *Gymnangium hians* and on coral rock, windward Great Astrolabe reef, 24 Jun. 78 (QM GL10222).

WORLD DISTRIBUTION

Warm water cosmopolitan.

Sertularella minuscula Billard, 1924 (Fig. 33)

Sertularella minuscula Billard, 1924: 648

Sertularella minuscula: Billard 1925: 139

Sertularella minuscula Billard, 1924: Pennycuik 1959: 195; van Gernerden-Hoogeveen 1965: 34

DESCRIPTION

Colony comprising a hydrorhiza bearing erect, monosiphonic, unbranched stems reaching 7 mm. Proximally a short, athecate internode of variable length; then regular thecate internodes with oblique but indistinct nodes. Internodes long and slender, often annulated at base. Hydrothecae alternate, one per internode, lateral, in one plane; long, tubular, adnate for one-third to one-half of vertical height, but for less than one-quarter of the adcauline length. Curving gently outward; abcauline wall straight or slightly concave, adcauline convex; angle of adcauline wall with

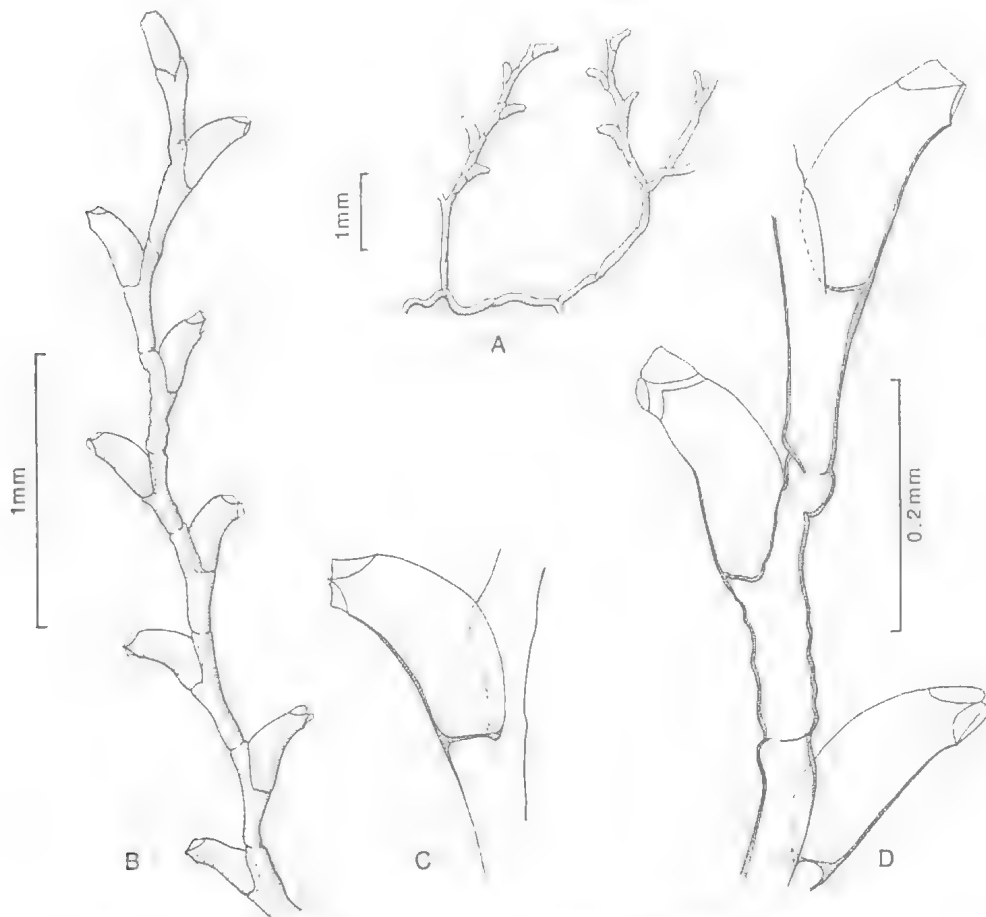


FIG. 33. *Sertularella minuscula*. A, habit; B, stem; C, D, hydrothecae. Thangilai (QM GL10223).

stem axis 30–60°; smooth; margin narrow, facing out and up, with four distinct cusps, not thickened and without internal cusps; renovation common. Gonothecae not observed; see van Gernerden-Hoogeveen (1965) for description.

MEASUREMENTS (μm)

Internode length: 330–480. Hydrotheca: adcauline free length 140–240; adcauline adnate length 110–165; abcauline length 200–325; marginal diameter 80–105; vertical height 200–290.

VARIATIONS

Branches, originating from within damaged hydrothecae, occur rarely and have the same structure as the stem. Solitary hydrothecae arise at irregular intervals from the hydrorhiza.

OCCURRENCE IN FIJI

On coral rock, edge of Thangilai reef, 28 Apr. 79 (QM GL10223); Suva barrier reef, 19 Feb. 80; Great Astrolabe Reef, 12 Jul. 80; on coral rock and algae, Ndeumba, 18 Mar. 79 (QM GL10224).

WORLD DISTRIBUTION

Tropical and sub-tropical waters: Indian Ocean (Gulf of Manar, Indonesia (Timor), Great Barrier Reef (Heron and Low Is.), Caribbean (Bonaire).

Sertularia Linnaeus, 1758 *Sertularia borneensis* Billard, 1924 (Fig. 34)

Sertularia borneensis Billard, 1924: 649

Sertularia borneensis: Billard 1925: 171

Sertularia borneensis Billard, 1924: Pennycuik 1959: 197

Sertularia westindica Stechow: Cooke 1975: 100

Sertularia turbinata: Vervoort and Vasseur 1977: 60

DESCRIPTION

Colony comprising a hydrorhiza bearing erect, monosiphonic, unbranched stems reaching 13 mm; nodes oblique, with a hinge joint terminating the short basal athecate part of the stem; each internode bearing a pair of opposite hydrothecae; members of pair may be contiguous in front but most are separate both in front and behind.

Hydrothecae without abcauline intrathecal septum; swollen basally, narrowed above; outcurved. Angle of adcauline wall with stem axis variable, 70–90°; contiguous for more than one-half vertical height. Shoulder variably prominent, related to degree of hydrothecal contiguity; more or less at point of hydrothecal separation. Margin



FIG. 34. *Sertularia borneensis*. A, Part of stem; B, basal pair of hydrothecae; C, more distal pair of hydrothecae; D, gonotheca, QM GL10225, Philippines.

thickened, with three cusps: two well-developed triangular midlaterals and one small adcauline cusp. Ab- and adcauline walls thickened, with one small, abcauline internal cusp.

Gonothecae (based on specimen collected by JSR from Verde I. Passage, Philippines, 24 May 81) on stem at colony base below the first pair of hydrothecae. Elongate, barrel-shaped, narrowing distally. Aperture on short but distinct collar with two lateral 'horns'; distinctly ridged and pagoda-like.

MEASUREMENTS (μm)

Measurements for Fiji; Vervoort and Vasseur (1977), Siboga Stn. 80 material (cf. Billard, 1925); and Vervoort and Vasseur (1977), Moorea respectively. Hydrotheca: vertical height 190–285, 295–325, 255–260; adnate adcauline length: 200–230, 160–175, 120–135; free adcauline length 95–135, 245–260, 200–215; marginal diameter 95–120, 95–110, 70–80. Internode length: 490–1025, 525–555, 365–405. Gonothecae (two only, Philippines): length 1170, marginal diameter 378–432.

VARIATIONS

As in *S. turbinata*, proximal hydrothecae are short and squat, and rarely contiguous in front; each makes an angle of divergence of approximately 90°, and has a distinct basal swelling. Distal hydrothecae may become contiguous; each has a reduced angle of divergence, an indistinct basal swelling, and is more upright. Hydrothecae may occur in sub-opposite pairs. Some internodes may have more than one pair of hydrothecae, in which case the internode is long and bears proximal and distal pairs. Hydrothecae may be grossly enlarged,

up to 2.5 times normal volume. Margin renovation is common. Tendrils commonly arise at stem apices, insert on the substratum and ramify, throwing up new colonies. Branching rare: basal athecate internode may branch dichotomously and bear a transverse node terminally; then typically a second athecate but short internode (with terminal hinge joint) follows before the normal pattern is resumed.

REMARKS

Sertularia borneensis, first described by Billard (1924) and subsequently identified from Queensland by Pennycuik (1959), has had a chequered taxonomic history. Mammen (1965) and Cooke (1975) referred it to *S. westindica* Stechow, 1919b, and Vervoort and Vasseur (1977) to *S. turbinata* (Lamouroux, 1816). The type material of *S. westindica* unfortunately lacked gonothecae. Billard (1925) himself recognized the similarity between *S. borneensis* and *S. westindica*, but Mammen's arguments for merging the two are far from convincing, being based on characters of acknowledged variability. He noted a general resemblance between them which we find unsupported by the relevant illustrations (Stechow, 1919b, fig. 6; Mammen, 1965, fig. 71). While the two nominal taxa may yet prove to be the same species, merging seems premature so long as the reproductive structures in *S. westindica* s. str. remain undescribed.

S. turbinata is characterized by its abcauline intrathecal septum, a feature noted to some extent in all the descriptions prior to Vervoort and Vasseur (1977). Their merging of the two species was based on an observation that young and developing colonies from Moorea, lacking abcauline intrathecal septa, were identical with those described and illustrated by Billard (1925) as *S. borneensis*: an observation that was supported by an examination of the holotype. However, in our opinion, their material should have been referred to *S. borneensis*. On the evidence of material from Fiji, we disagree with Vervoort and Vasseur that the absence of the septum in *S. turbinata* is a juvenile character. Our material of *S. borneensis* was of good height and in reproductive condition, but otherwise identical with Vervoort and Vasseur's (1977) description. Moreover, the gonothecae are different from those described in published accounts of *S. turbinata*.

No gonosomal material of *S. borneensis* was reported by either Billard or Pennycuik (1959), and the gonothecae in our material are different from those described by Mammen for *S. westindica*. We feel justified in referring our specimens to *S. bor-*

neensis since they are from the Philippines, much closer to the type locality than Mammen's collection.

It appears that many species of *Sertularia* have hydrothecae that are similar but differ in their gonothecae. We provisionally refer both the infertile colonies from Fiji and *S. westindica* sensu Cooke (1975) to the present species.

OCCURRENCE IN FIJI

Thangilai reef, 28 Apr. 78; on red algae, Ndeumba fringing reef, 13 Dec. 78 (QM GL 10226); on coral rock, windward Great Astrolabe reef, 12 Jul. 80. Also from Verde Island, Philippines, 24 May 81 (QM GL 10225).

WORLD DISTRIBUTION

Indonesia (Makassar Strait), Philippines, Great Barrier Reef, Marshall Islands, French Polynesia.

Sertularia hupferi Broch, 1914
(Fig. 35)

[?] *Sertularia rugosissima* Thornely, 1904: 118

Sertularia hupferi Broch, 1914: 34

Sertularia hupferi Broch, 1914: Millard and Bouillon 1973: 72

DESCRIPTION

Colony comprising a hydrorhiza bearing erect, monosiphonic, unbranched stems reaching 3.5 mm; nodes acutely oblique, resembling hinge joints. Basal athecate part of colony always short and sometimes with a proximal transverse node. True hinge joints terminate the basal part of the stem and may occur sporadically in the distal region. Each internode bearing a pair of opposite hydrothecae, contiguous in front (except often at colony base), separate behind.

Hydrotheca without intrathecal septum, basal swelling slight; narrowing above; outcurved; angle of adcauline wall with stem axis 60–80°; shoulder discernible but not prominent, more or less at point of hydrothecal separation; with about 20 transverse ridges, these rarely complete, but approaching the contiguous wall distally; incomplete ridge ends united by a longitudinal ridge. Margin delicate, with three marginal cusps: two unridged, pointed laterals displaced slightly to the adcauline edge, one small adcauline cusp. Hydrothecae thickened on abcauline wall and with a distinct abcauline internal cusp.

Gonothecae not observed.

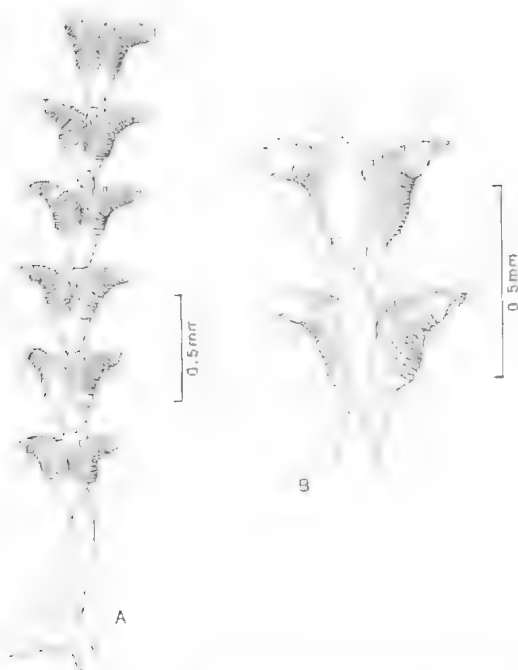


FIG. 35. *Sertularia hupferi*. A, stem, from anterior; B, two pairs of hydrothecae, from posterior, QM GL10227, Suva Barrier Reef.

MEASUREMENTS (μm)

Measurements for *S. rugosissima* (BM 1907.8.27.6); Millard and Bouillon (1973); and Fiji respectively. Hydrotheca: vertical height 275–360, 140–290, 150–170; adnate adcauline length 225–255, 150–270, 175–225; free adcauline length 200–275, 110–120, 125–200; marginal diameter 100–130, —, 40–70; contiguous length 75–130, —, 75–145. Internode length: 500–600, —, 325–380.

VARIATIONS

Adnate hydrothecal length increases and the angle of divergence decreases distad. In some specimens a faint, second, internal adcauline cusp was observed.

REMARKS

This material agrees very well with that from the Seychelles (Millard and Bouillon, 1973): but there is also a resemblance to *S. rugosissima* Thornely (1904), from Ceylon. The type slide (BM 1907.8.27.6) reveals that Thornely's illustration is inaccurate and that *S. rugosissima* possesses one, very prominent, abcauline internal cusp and possibly also a second fainter, adcauline one; the hydrothecae are also more extensively adnate than shown. The hydrothecae are much larger than in

our material (though the specimen is very squashed). In the absence of a sufficient range of material, however, we feel it best to refer our material to *S. hupferi*. Thornely (1916) herself later referred *S. rugosissima* to *S. hupferi* (see Cornelius, 1979, p.308, note 5). Although this material may superficially resemble *Diphasia tropica* Nutting, 1904, and *D. delagei* Billard, 1912 (see Cornelius, 1979), it differs from them in two fundamental ways: the presence of an abcauline caecum, and the narrowing, not flaring, of the hydrotheca towards the margin.

OCCURRENCE IN FIJI

On red algae, Ndeumba fringing reef, 13 Dec. 78, 9 Sep. 79; on coral rock at reef crest, Suva barrier reef, 27 Apr. 79 (QM GL10227).

WORLD DISTRIBUTION

West Africa (Ghana), the Seychelles.

Sertularia ligulata Thornely, 1904 (Fig. 36)

Sertularia ligulata Thornely, 1904: 116

Sertularia ligulata Thornely: Billard 1925: 178

Sertularia ligulata Thornely, 1904: Millard 1975: 307

DESCRIPTION

Colony comprising a hydrorhiza bearing erect, monosiphonic, unbranched stems reaching 7 mm. Internodes long; nodes indistinct, slightly oblique; hinge joints occurring only to terminate the basal athecate internode; each internode bearing one distal pair of opposite hydrothecae; members of a pair contiguous in front, separate behind.

Hydrotheca with abcauline intrathecal septum; not swollen below but narrowing above; outcurved; angle of adcauline wall with stem axis 55–60°, contiguous for more than three-quarters of vertical height; free adcauline wall short. Margin delicate, more or less parallel with stem axis; two poorly developed lateral cusps, displaced slightly to the adcauline edge, and a small adcauline cusp; the cusps may be extended beyond opercular valves, especially on the adcauline side. Hydrotheca unthickened, with a small abcauline internal cusp present. Gonotheca not observed, but borne on stem below hydrotheca, barrel-shaped and with about three annulations (Thornely, 1904).

MEASUREMENTS (μm)

Internode length: 630–720. Hydrotheca: contiguous adcauline length 165–200; adnate adcauline

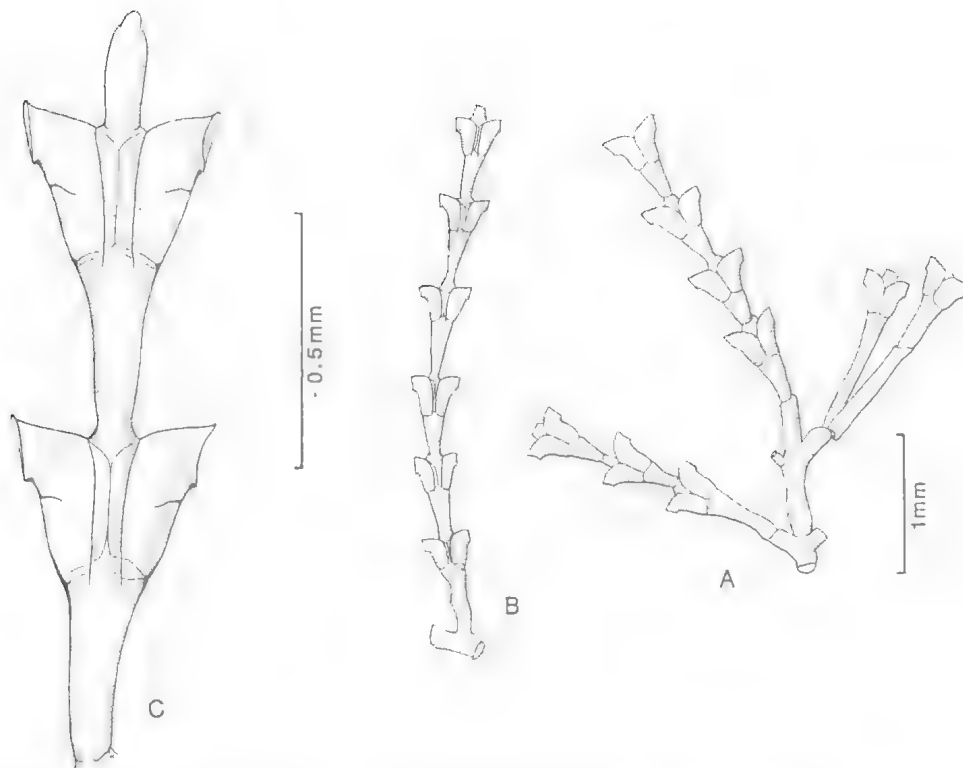


FIG. 36. *Sertularia ligulata*. A,B, stems; C, two pairs of hydrothecae. QM GL10228, Mba.

length 250–275; free adcauline length 135–155; abcauline length 190–215; marginal diameter 90–120.

VARIATIONS

The hydrothecae are symmetrical and uniform in size and shape throughout a colony. Branching was rarely observed; it may take place from one of a pair of damaged hydrothecae at the colony base, the branch having an athecate basal internode terminated by a hinge joint. Tendrils resembling hydrorhizae commonly arise from stem tips. The adcauline opercular valve is extremely difficult to observe, even by SEM, so that the species might easily be mistaken for a species of *Salacia*. However, the ligula (a leaf-shaped process on adcauline side of hydranth which projects through the mouth of the hydrotheca when extended) is diagnostic of this species, though it may be difficult to observe in contracted hydranths.

REMARKS

This material is closer to that described and illustrated by Billard (1925) and Millard and

Bouillon (1973) than to that of Millard (1975) and Vervoort and Vasseur (1977). The specimens of the last authors differ in hydrothecal shape: the free adcauline wall being longer, the angle of divergence less acute, and the contiguity between hydrothecae shorter, than in our material.

OCCURRENCE IN FIJI

Under coral boulder, Yarawa reef, Mba, 8 Nov. 78 (QM GL10229); on rock and algae, Ndeumba, 18 Mar. 79 (QM GL10228); on coral rock windward Great Astrolabe reef, 25 Jul. 78, 12 Jul. 80.

WORLD DISTRIBUTION

Western and southern Africa, tropical Indo-west Pacific, Japan and French Polynesia.

Sertularia malayensis Billard, 1924 (Fig. 37)

Sertularia malayensis Billard, 1924: 649
Sertularia malayensis: Billard 1925: 173

Sertularia malayensis Billard, 1924: Vervoort and Vasseur 1977: 57

Sertularia malayensis Billard, 1925: Hirohito 1983: 49

DESCRIPTION

Colony comprising a hydrorhiza bearing erect, monosiphonic, unbranched stems, reaching 5.5 mm; nodes very oblique, resembling hinge joints; internodes long and slender, each typically bearing one proximal pair of opposite hydrothecae. Basal athecate internode long, making up as much as one-third of the total stem height.

Hydrothecae in pairs, contiguous in front but separate behind, rarely perfectly symmetrical. Each slender and tubular, without intrathecal septum, characterized by the long, thin free portion; with slight, indistinct basal swelling, narrowing a little to margin above; outcurved at 55–80°. Contiguous for more than one-half of

vertical height but only one-quarter of adcauline length. Shoulder of variable prominence, more or less at point of adnate divergence, decreasing distad. Margin delicate, with two well developed, pointed, midlateral cusps.

Gonothecae borne on stem just below hydrothecae, shortly pedicellate, spherical, smooth, with wide aperture and short collar (Hirohito, 1983); not observed in our material.

MEASUREMENTS (µm)

Measurements for Fiji; Billard (1925); Hirohito (1974) *Tridentata* sp.; and Vervoort and Vasseur (1977) respectively, Hydrotheca: adnate length 90–115, 115–125, 140–170, 85–100; contiguous length 55–100, —, 120–150, —; adcauline length 105–200, 185–205, 130–210, 170–190; marginal diameter 35–50, 55–60, 50–60, 45–50; width at base 40–55, —, 50–70, —; width at flexure 150–275, —, —, —. Stem diameter: 24–43, 40–60, —, 40–45. Base-base distance: 360–545, 405–630, 420–520, 195–350.

VARIATIONS

Length of adnate portion of hydrothecae increases, and the angle of divergence decreases, distad. Many internodes have well separated proximal and distal pairs of hydrothecae; such internodes tend to be terminated by a transverse node immediately above the distal pair. Short interpolated athecate internodes common, terminated by either an oblique or a transverse node.

REMARKS

Our material agrees well with that described by Vervoort and Vasseur (1977) and, like theirs, lacks any internal cusps (compare the description by Hirohito (1974) of a superficially similar species of *Tridentata*). However, our specimens are smaller than others previously referred to *S. malayensis* (though in all characters the ranges overlap). *Sertularia gracilis* Hassall, 1848, as described and illustrated by Thornely (1904) from material collected off Ceylon (Sri Lanka) is more similar in size. *S. gracilis* is usually now referred to *S. distans* Lamouroux (Millard, 1975; Cornelius, 1979). Since the type (now destroyed but examined by Billard, 1906) was from 'Australasia' (Lamouroux, 1816), *S. distans* might be expected to occur in the Fiji area. Pennycuik (1959, pl. VI, fig. 6) illustrated long slender, but much renovated, hydrothecae in this species. The third marginal cusp that she indicated is apparently a variable character (Cornelius, 1979).

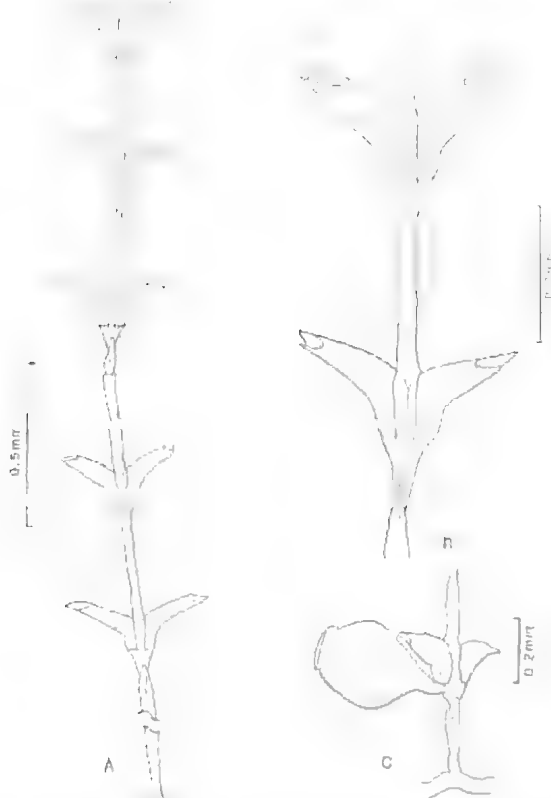


FIG. 37. *Sertularia malayensis*. A, portion of stem showing internodes; B, hydrothecae. Suva barrier reef (QM GL10230); C, gonotheca (after Hirohito, 1983).

OCCURRENCE IN FIJI

Several times under intertidal boulders, Suva barrier reef (QM GL10230).

WORLD DISTRIBUTION

Indonesia (Makassar Strait), Japan (Sagami Bay, Honshu), French Polynesia (Moorea).

Sertularia orthogonalis sp. n.
(Fig. 38)

MATERIAL EXAMINED

HOLOTYPE: Slides QM GL10231/2; BM 1988.11.12.1), Ndeumba, 20 Aug. 1978.

PARATYPES: Slides QM GL10233/4, Ndeumba, 8 Jul. 79; unmounted, Ndeumba, 9 Sep. 79 (BM 1984.5.17.26).

TYPE LOCALITY: Ndeumba fringing reef, Pacific Harbour, Viti Levu (Fig. 1, locality 12).

DERIVATION OF NAME

Gr. *orthos*, straight, right; *gonia*, angle: referring to the strikingly orthogonal arrangement of hydrothecal pairs on the erect stems.

DESCRIPTION

Colony comprising hydrorhiza with erect, monosiphonic, unbranched stems reaching 12 mm; stem nodes slightly oblique and indistinct; true hinge joints irregular in occurrence: one may terminate short basal athecate internode and others sometimes occur sporadically distally. Internode long, bearing one distal pair of opposite hydrothecae; members of a pair contiguous in front but separate behind.

Hydrothecae with abcauline intrathecal septum, slightly swollen below and narrowing to margin above; outcurved; contiguous for more than three-quarters of the vertical height, thickened on the abcauline wall. Abcauline caecum present. Angle

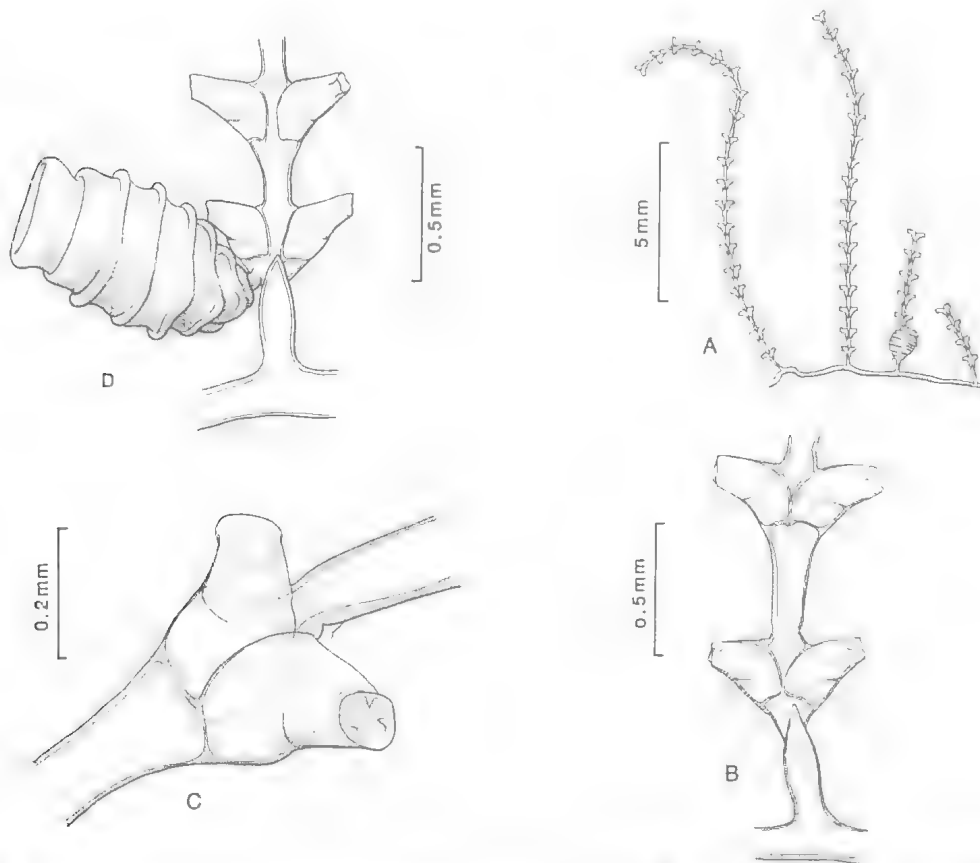


FIG. 38. *Sertularia orthogonalis* sp.n. A-C, holotype: A, part of colony; B, stem base with hinge joint; C, hydrothecae showing internal teeth; D, gonotheca (QM GL10234). Ndeumba.

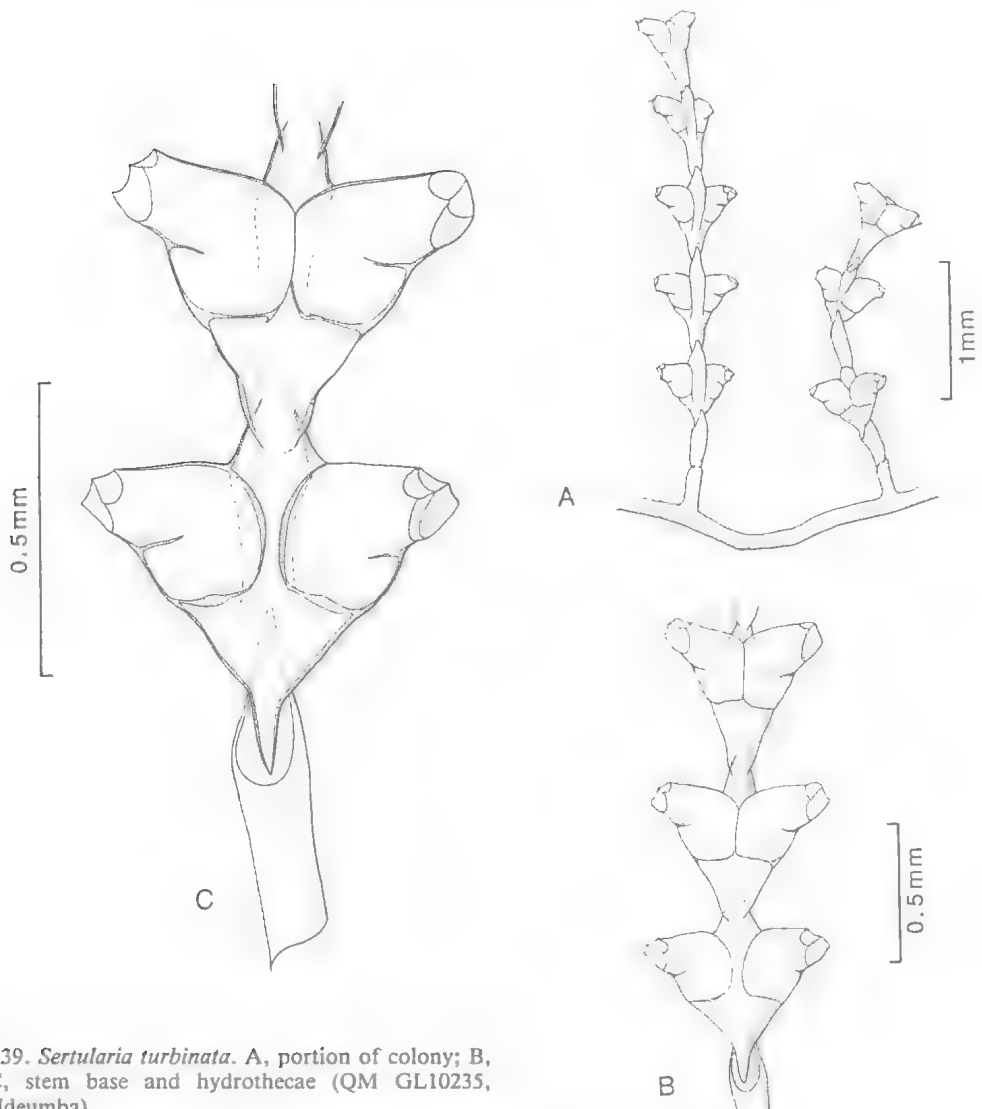


FIG. 39. *Sertularia turbinata*. A, portion of colony; B, C, stem base and hydrothecae (QM GL10235, Ndeumba).

of adcauline wall with stem axis always sharp, approximately 90° , hence margin more or less parallel with stem. Shoulder rounded at point of adnate divergence; base oblique, sloping from contiguity. Margin thickened, with three marginal cusps: two rounded laterals displaced slightly to the adcauline edge, and one small adcauline cusp; three distinct internal cusps: one abcauline and two latero-adcauline. Operculum of two valves, one large abcauline and one small adcauline; caducous.

Gonothecae borne near base of stem, below the first pair of hydrothecae. Barrel-shaped, with a broad distal aperture on a short but distinct collar; annulated.

MEASUREMENTS (μm)

Internode: width 100–125; length 700–850. Hydrotheca: adnate length 225–255; contiguous length 115–140; free adcauline length 190–225; vertical height 210–250; width from midline to outer edge 280–320; marginal diameter: 80–100. Gonotheca: length 936–1080; marginal diameter 396–594.

VARIATIONS

Basal internode usually thecate, with a transverse node immediately above hydrothecae. Hydrothecae becoming gradually more erect, adnate and contiguous distad, the angle of divergence, however, decreasing little. Branches rare:

may replace one (damaged) of a pair of hydrothecae at colony base, or arise irregularly above and/or below any hydrothecal pair; always having an athecate basal internode with terminal hinge joint; distally they resemble the stem.

REMARKS

The superficial resemblance between this species and *Sertularia tongensis* Stechow, 1919a, is striking: long internodes, orthogonal hydrothecae with parallel margins and three indistinct marginal cusps. However, Stechow observed neither an abcauline intrathecal septum nor three prominent internal cusps. Consequently, we consider our material distinct.

OCCURRENCE IN FIJI

Several records from Ndeumba, on algae, bryozoans and coral rock; reproductive 20 Aug. 78, 18 Mar. 79, 8 Jul. 79.

Sertularia turbinata (Lamouroux, 1816) (Fig. 39)

Dynamena turbinata Lamouroux, 1816: 180

Sertularia turbinata (Lmx): Billard 1925: 177

Sertularia turbinata (Lamouroux, 1816): Millard 1975: 312

[non] *Sertularia turbinata* Vervoort and Vasseur 1977: 60

DESCRIPTION

Colony comprising a hydrothiza bearing erect, monosiphonic, unbranched, stems reaching 6.5 mm. Nodes oblique, resembling hinge joints from behind; each internode bearing a pair of opposite hydrothecae. True hinge joints terminating the short basal athecate part of stem (which may be subdivided proximally by one or more transverse nodes), and occurring sporadically at the end of stems, terminating an extra, athecate internode. Hydrothecae of pair contiguous in front (except often at colony base) for more than half vertical height, separate behind; swollen below and outcurved above. Angle of adcauline wall with stem axis variable, 70–90°; both ab- and adcauline walls thickened; with abcauline intrathecal septum. Shoulder not prominent, often indistinct, shifted along adcauline wall from point of hydrothecal separation. Margin thickened; with a pair of well developed triangular midlateral cusps, and a small adcauline cusp; no internal cusps.

Gonotheca borne at stem base, below the first pair of hydrothecae; barrel-shaped, annulated, and with a broad distal aperture (Millard, 1975); not observed in our material.

MEASUREMENTS (µm)

Internode length: 500–650. Hydrotheca: vertical height 215–300; contiguous length 95–190; adnate adcauline length 215–240; free adcauline length 150–250; marginal diameter 105–135.

VARIATIONS

Proximal hydrothecae short and squat, angle of divergence about 90°, hence margin more or less parallel with the stem axis; members of a pair of hydrothecae usually separated in front as well as behind. Distal hydrothecae appear taller and less squat; angle of divergence less, the pair contiguous in front (often for majority of vertical height), the abcauline swelling indistinct. The material examined did not possess any internal cusps.

REMARKS

A variable species with several described forms. Our material resembles var. *acuta* (Stechow, 1921a) basally but var. *turbinata* distally.

Unlike the specimens illustrated by Vervoort and Vasseur (1977), and despite the fact that the maximum height of our material was only two-thirds of theirs, ours always possessed an abcauline intrathecal septum. This was usually complete in the basal, older hydrothecae but sometimes incomplete and patchily developed distally.

OCCURRENCE IN FIJI

Several records on *Sargassum* and red algae, LWST, Ndeumba fringing reef (BM 1984.5, 17.35–37; QM GL10235/6); also on coral rock, windward Great Astrolabe reef, 12 Jul. 80.

WORLD DISTRIBUTION

Warm water cosmopolitan.

Thyroscyphus Allman, 1877 *Thyroscyphus fruticosus* (Esper, 1793) (Fig. 40)

Spongia fruticosa Esper, 1793: 188

Thyroscyphus vitiensis Marktanner-Turneretscher, 1890: 210

Thyroscyphus vitiensis Marktanner-Turneretscher, 1890: Jarvis 1922: 338

Thyroscyphus vitiensis Marktanner: Billard 1907: 343

Thyroscyphus fruticosus (Esper, 1793): Millard 1975: 323

Thyroscyphus vitiensis Marktanner-Turneretscher, 1890: Spletstösser 1929: 122; Cooke 1975: 94

DESCRIPTION

Colony of erect stems arising from hydrothiza; stem stiff, thick basally but monosiphonic; giving

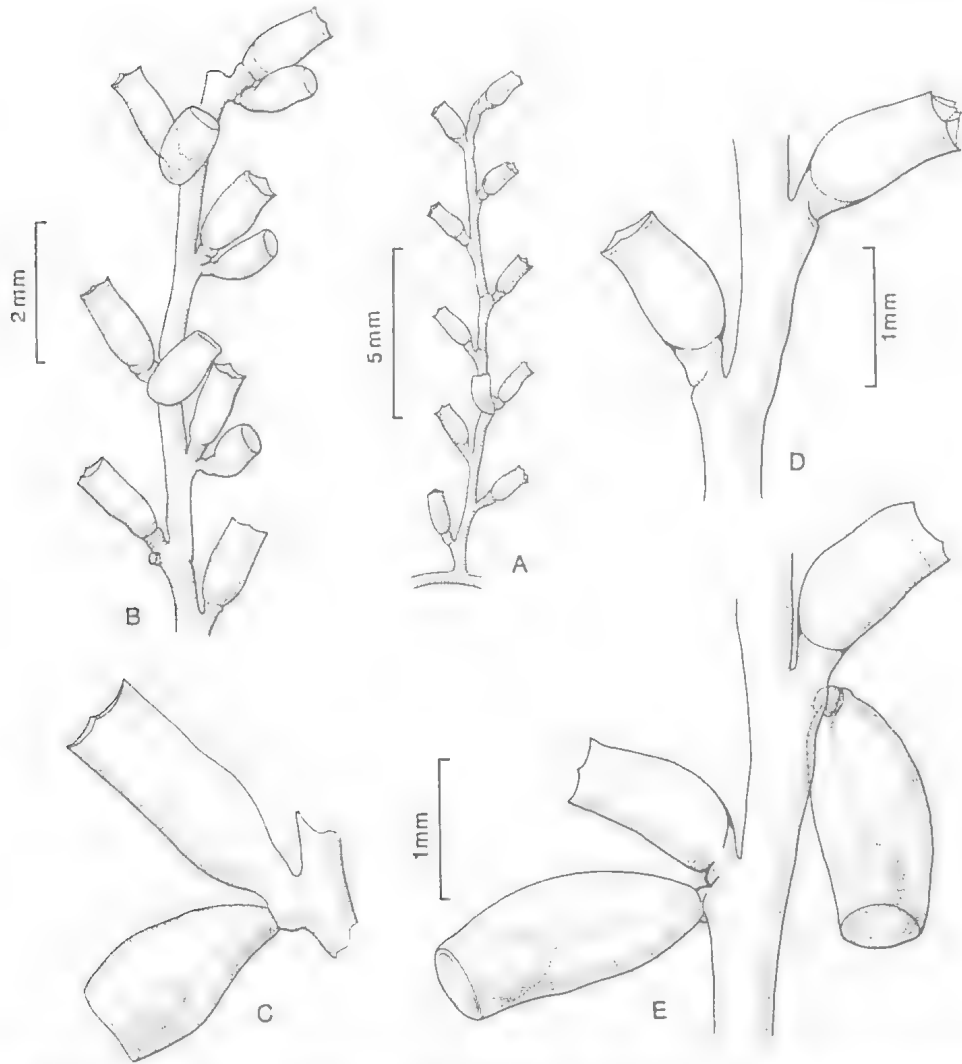


FIG. 40. *Thyroscyphus fruticosus*. A, stem; B, C, hydrothecae and female gonothecae (QM GL10238); D, detail of hydrothecae (QM GL10239) A-D, Suva Barrier Reef; E, male gonothecae (QM GL10237, Philippines).

off alternate hydrocladia in one plane; reaching 85 mm. Stem and hydrocladia bearing alternate, regularly spaced hydrothecae on short, thick, non-annulated pedicels; nodes indistinct; axillary hydrothecae always present. Pedicel borne on an anteriorly directed apophysis; node indistinct, such that apophysis and pedicel may appear continuous. Hydrotheca tubular, not expanding to margin, convex on adcauline side and more or less straight on abcauline. Margin with four low cusps; a narrow, interior ridge just below the rim at first supports four triangular opercular valves, but these are caducous and rarely present. Diaphragm

an oblique perisarc ring, better developed on the ad- than on the abcauline side.

Gonothecae borne on hydrothecal apophyses of both stem and hydrocladia. In male smooth, cylindrical, truncated distally, slightly longer than hydrothecae and directed down and outwards; wider and shorter in female.

MEASUREMENTS (μm)

Hydrotheca: length 1063–1329; marginal diameter 414–486. Stem internode: 288–720. Gonotheca (male, Philippines): length 1812–2103;

marginal diameter: 468–551. Gonotheca (female): length 1160–1257; marginal diameter 468–774.

VARIATIONS AND REMARKS

Colonies on Fiji tend to form two size groups: below 20 mm and above 40 mm. The former are usually confined to coral rock, particularly the undersides of boulders, and typically lack hydrocladia, while the latter grow from an attachment up through sand, and are well branched with long hydrocladia.

Millard (1975) described living colonies of *T. fruticosus* as being pale rose in colour, whereas Cooke (1975) has pointed out that '*T. vitiensis*' is purple. In Fiji both the tall and short colonies tend to be violet, though the short ones may be orange, especially when on the underside of rubble where the water circulation may be poor. Both become yellow on preservation.

Previous authors have merged *T. vitiensis sensu* Billard (1907) with *T. fruticosus*, for example, Billard (1933), Millard and Bouillon (1973), and Hirohito (1974). However, *T. vitiensis* Marktanner-Turneretscher, 1890, has not been included. Yet the hydrothecal structure is more or less identical and nodal development similarly variable in both nominal species. Hirohito (1974), following Splettstösser (1929), explained that the differences are based on growth form, *T. fruticosus* being monopodial and *T. vitiensis* sympodial. The small colonies around Fiji do indeed resemble the illustration by Cooke (1975, Pl. 3, fig. 1) of *T. vitiensis* and a majority of specimens show sympodial growth; but monopodial growth is evident at the tip of the stem in some. The taller colonies resemble fig. 104 of Millard's (1975) monograph and generally display monopodial growth; but they can also show signs of sympodial growth, as examination of the growing hydrocladial tips reveals. There are no significant differences between the thecal dimensions and structure of the two types and, moreover, the gonothecae (males on the tall colonies; females on the short ones) conform to those in previous descriptions of *T. fruticosus*. In our view, the material of *T. fruticosus* from around Fiji is capable of both sympodial and monopodial growth, and *T. vitiensis* Marktanner-Turneretscher (1890) should not be maintained as a separate species.

OCCURRENCE IN FIJI

In two habitats: small colonies found under boulders, large colonies growing upright through sand on outer reef flats. Particularly common intertidally in the Suva area (BM 1984.5.17.27–32;

QM GL10238/39/40): Nukumbutho, Suva barrier and Joske's reef, in sand; under boulders there and at Ndeumba. Less common on the 'Coral Coast' fringing reefs. Colonies often have associated *Hebella scandens* (QM GL10191). Many samples were collected but gonothecae observed only in March and May. Also Philippines, Verde I. Strait (fertile male), 25 May 81 (QM GL10237).

WORLD DISTRIBUTION

Mediterranean and Indo-West Pacific, reaching New Zealand (Millard, 1975).

Thyroscyphus sibogae Billard, 1930 (Fig. 41)

Thyroscyphus sibogae Billard, 1930: 230

Thyroscyphus sibogae Billard, 1930: Pennycuik 1959: 198

DESCRIPTION

Colony with erect stems arising from hydrorhiza. Stems monosiphonic; typically unbranched; reaching 12 mm (usually less). Stem slightly geniculate with alternate hydrothecae; nodes indistinct, oblique; internodes regular, with distal apophysis. Apophyses of variable length, usually short, terminated by an indistinct partial or complete node. Pedicel of variable length, annulated irregularly, with one or more nodes. Hydrothecae in plane of



FIG. 41. *Thyroscyphus sibogae*. A, stem; B, hydrotheca; C, hydrotheca and gonotheca (QM GL10242). Suva barrier reef.

stem and directed upwards, parallel with the stem axis; ovoid to barrel-shaped, with a series of strong transverse ridges extending from the pedicel to just below the margin. As seen from certain angles, the hydrotheca may appear to have a convex adcauline side and a straight abcauline one. Margin delicate, with four smooth triangular cusps; occasionally renovated. Diaphragm an oblique perisarc ring, most developed on the adcauline side.

Gonothecae arising from hydrothecal apophyses, pedicellate, usually directed out and down, not in the same plane as the remainder of the colony; obovoid, truncated distally; aperture with tetrad of small 'horns'. Gonotheca and pedicel annulated.

MEASUREMENTS (μm)

Hydrotheca: depth 510–770; marginal diameter 280–330; diameter at diaphragm 100–170. Internode length 450–650. Gonotheca: length 720–870; marginal diameter 330–440.

VARIATIONS

Single hydrothecae may arise from the hydrorhiza; gonothecae do not. More than one hydrotheca may be present per apophysis. Stems may branch dichotomously at base.

REMARKS

The present material resembles in every way the description and illustration of this species given by Billard (1930) and with the comments and remarks made by Pennycuik (1959). Gonothecae have not previously been described.

OCCURRENCE IN FIJI

On coral rock: Suva barrier reef (several times, reproductive 27 Apr. 79 (QM GL10242/3)); Nukumbutho reef, 11 Jun. 80; Joske's reef, 18 Sep. 78; Ndeumba fringing reef, 8 Jul. 78 (BM 1984 5.17.33)

WORLD DISTRIBUTION

Indonesia (Timor) and Great Barrier Reef (Low Is.).

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SOME NEW MIMETID SPIDERS FROM NORTH QUEENSLAND, AUSTRALIA (ARACHNIDA, ARANEAE, MIMETIDAE)

STEFAN HEIMER

Heimer, S. 1989 11 13: Some new mimetid spiders from north Queensland, Australia (Arachnida, Araneae, Mimetidae). *Mem. Qd Mus.* 27(2): 433-435. Brisbane. ISSN 0079-8835.

Mimetus catulli sp. nov. and *Mimetus hannemanni* sp. nov. are the first records from Australia of the recently delimited genus *Mimetus*. They were discovered along with *Australomimetus andreae* sp. nov. on Bellenden Ker Range, north Queensland, by a combined Queensland Museum-Earthwatch expedition in October, 1981.

Mit *Mimetus catulli* sp. nov. und *Mimetus hannemanni* sp. nov. werden erstmals Vertreter der Gattung *Mimetus* in Australien nachgewiesen. Beide Arten wurden zusammen mit *Australomimetus andreae* sp. nov. in Bellenden Ker Range, Nord-Queensland, durch die Queensland Museum-Earthwatch Expedition im Oktober 1981 gesammelt.

□Taxonomy, *Mimetus*, *Australomimetus*, *Mimetidae*

Stefan Heimer, Staatliches Museum für Tierkunde, Augustusstr. 2, Dresden, DDR-8010, German Democratic Republic; 9 March, 1988.

A number of mimetid spiders were collected during a combined Queensland Museum-Earthwatch expedition to Mt Bellenden Ker and Mt Bartle-Frere, North Queensland. The results of some observations on these spiders are given here. These provide some new records of *Australomimetus* as well as description of three new species of the genera *Australomimetus* and *Mimetus*. This is the first record of *Mimetus* species from Australia since taxonomic changes introduced by Heimer (1986). All specimens mentioned in this paper are deposited in the Queensland Museum (QM), Brisbane, Australia.

Mimetus catulli sp. nov. (Figs 1, 2)

MATERIAL EXAMINED

HOLOTYPE: QM S6741, male from Bellenden Ker Range, Cableway Base Station, 100m, October 17-24, 1981.

DESCRIPTION

Cephalothorax: 2.3mm long, 1.7mm wide, light yellow. Between fovea and eye region an irregular bordered band, light brown. Maxillae and sternum yellow, labium yellowish brown, chelicerae brown, its basic parts yellowish.

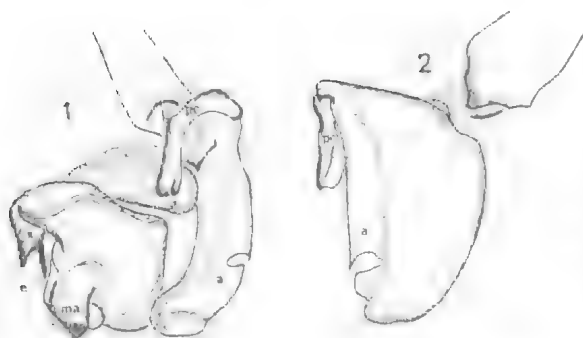
Abdomen: 2.3mm long, 1.9mm wide, light yellow with indistinct grey spots. Dorsal side in posterior third with white band reaching spinnerets. Two flat hooks on dorsal side of abdomen near half of its length. Ventrally lighter in color than dorsal side. Genital opening marked with brown spot.

Legs: Light yellow. Distal parts (excluding tarsi) and II light brown. Femora, tibiae and metatarsi with indistinct light greyish brown spots and rings. Spination as for the genus. Measurements of the legs are given in Table 1.

TABLE 1. Measurements (in mm) of the legs of *Mimetus catulli* (MC), *Mimetus hannemanni* (MH), and *Australomimetus andreae* (AA). Fe = femur, Pt = patella, Ti = tibia, Mt = metatarsus, and T = tarsus.

		I	II	III	IV
MC	Fe	4.5	3.4	2.4	3.0
	Pt	1.0	0.8	0.6	0.7
	Ti	4.7	2.9	1.7	2.2
	Mt	5.0	3.0	1.8	2.3
	T	1.8	1.4	1.0	1.1
MH	Fe	4.4	3.3	2.3	3.0
	Pt	1.1	1.0	0.6	0.7
	Ti	4.5	4.4	1.8	2.6
	Mt	4.8	3.0	1.4	2.2
	T	1.6	1.4	0.7	1.0
AA	Fe	3.9	3.0	1.8	2.2
	Pt	0.9	0.7	0.3	0.5
	Ti	3.9	2.6	1.2	1.9
	Mt	3.6	2.5	1.2	1.8
	T	1.6	1.0	0.8	0.8

Palp: Cymbium (Figs 1, 2) at its dorsal edge with a notched, shovel-like appendage (a). Paracymbium (pc) large, complex; its base largely hollowed out. Distal part of paracymbium long, curved. Bulb large. Tegulum with strong but short apophysis (x) near base of embolus (e). Median apophysis (ma) composed of several flat and shovel-like parts.



FIGS 1, 2. *Mimetus catulli* sp. nov. 1: Right male palpus, retrolateral view. 2: Right male palpus, cymbium, dorsal view. Scale line = 0.2mm.

ETYMOLOGY

The specific epithet is a patronym in honour of the Roman lyric poet Catull.

REMARKS

According to Heimer (1986) the new species is a typical *Mimetus* because of the spination of the legs and the appendage at the dorsal edge of the cymbium. The species can be separated from other *Mimetus* species by the shape of the paracymbium, the cymbial appendage, and the median apophysis.

Mimetus hannemanni sp. nov. (Figs 3, 4)

MATERIAL EXAMINED

HOLOTYPE: QM S6742, male, Bellenden Ker Range, Cable Tower 3, 1054m, October 17-24, 1981.

DESCRIPTION

Cephalothorax: 2.4mm long, 1.9mm wide, yellow with dark grey pattern. A grey band between fovea and petiolus. Cephalothorax in its posterior half with broad grey margin. Eye region dark grey, also some indistinct grey spots between eyes and fovea.

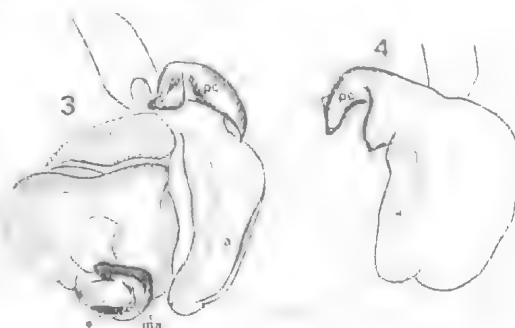
Sternum light yellow with grey spots between coxae I, II. Labium and maxillae light; chelicerae dark brown.

Abdomen: 2.2mm long, 1.5mm wide, light grey with several little white and yellowish spots. Dorsally a white band between the very flat hooks and spinnerets. Ventral side lighter than dorsal. Anterior spinnerets and genital opening marked with little brown spots.

Legs: Yellowish to light brown. Femora with

large grey spots and rings. Also tibiae II - IV with grey rings. Very strong spination in the typical arrangement of the genus. Measurements of the legs are given in Table 1.

Palp: Cymbium (Figs 3, 4) with flat appendage (a) at its dorsal edge. Paracymbium (pc) is a large hook with short lamella (l) near its distal end. At base of paracymbium a large but flat groove. Bulb large. Median apophysis (ma) very complex; at its base a rounded lamella which covers base of embolus (e). Distal end of median apophysis is strong curved swelling.



FIGS 3, 4. *Mimetus hannemanni* sp. nov. 3: Right male palpus, retrolateral view. 4: Right male palpus, cymbium, dorsal view. Scale line = 0.2mm.

ETYMOLOGY

The species is dedicated to Professor Dr H.J. Hannemann, Berlin, who has given valuable help to the author's scientific work.

REMARKS

This species is a typical *Mimetus* according to Heimer (1986). It can be separated from *Mimetus catulli* and other species by the lamella at the base of the median apophysis but also by the shape of paracymbium and cymbial appendage.

Australomimetus andreae sp. nov. (Figs 5, 6)

MATERIAL EXAMINED

HOLOTYPE: QM S6743, male from Bellenden Ker Range, 0.5km south of Cable Tower 7, 500m, October 17-24, 1981.

DESCRIPTION

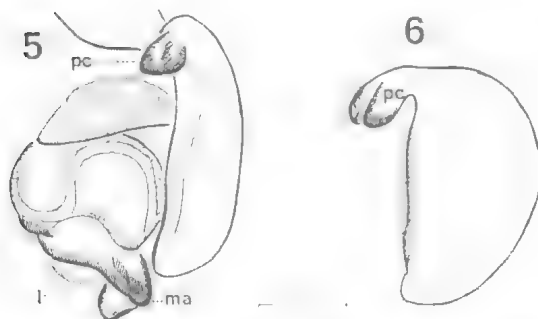
Cephalothorax: 2.1mm long, 1.5mm wide, yellow in colour. Cephalic part light brown with no pattern. Sternum light yellow. Maxillae and labium yellowish brown, chelicerae dark brown.

Abdomen: 2.0mm long, 1.6mm wide, light grey with little white spots. Its dorsal side with some

larger greyish spots which are arranged in two parallel rows between the very flat hooks and the spinnerets. Ventral side unicoloured yellowish. Anterior spinnerets and the genital opening are marked by light brown spots.

Legs: Light yellow. Distal parts (excluding tarsi) with indistinct brown spots and rings. Spination typical as in the Mimetidae, several spines very long and fine. Measurements of the legs are given in Table 1.

Palp: Cymbium (Figs 5, 6) with no appendage, at its dorsal edge only a flat ledge. Paracymbium (pc) simple and small. The large bulbus shows a median apophysis (ma) which is divided in a small lamella (l) at its base and two large rounded lobes distally. The relatively short and strong embolus is seen only in a ventral view of the palpus.



FIGS 5, 6. *Australomimetes andreae* sp. nov. 5: Right male palpus, retrolateral view. 6: Right male palpus, cymbium, dorsal view. Scale line = 0.2mm.

ETYMOLOGY

This new species is dedicated to my daughter Andrea.

REMARKS

This species is a typical *Australomimetes* of the *spinosis* group (Heimer, 1986), which is diagnosed by the absence of the cymbial appendage and the spination of the cephalothorax. It can be separated from the other species of this group by its simple paracymbium and the shape of the median apophysis.

Amongst the collections gathered by the Queensland Museum-Earthwatch expedition were new locality records for other species of *Australomimetes*. These were *A. burnetti* Heimer (QM S6744), *A. hirsutus* Heimer (QM S6747), *A. maculosus* (Rainbow) (QM S6748) and *A. daviesianus* Heimer (QM S6745) from Bellenden-Ker Range. The last mentioned species was also collected on Mt Bartle-Frere (QM S6746).

ACKNOWLEDGEMENTS

The author wishes to thank Dr Valerie Davies and Dr R.J. Raven for the loan of Australian mimetids as well as for their help in the preparation of this paper.

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ESPERIOPSIS DESMOPHORA N.SP. (PORIFERA: DEMOSPONGIAE): A DESMA-BEARING
POECILOSCLERIDA

JOHN N.A. HOOPER AND CLAUDE LEVI

Hooper, J.N.A. and Levi, C. 1989 11 13: *Esperiopsis desmophora* n.sp. (Porifera: Demospongiae): a desma-bearing Poecilosclerida. *Mem. Qd Mus.* 27(2): 437-441. Brisbane. ISSN 0079-8835.

A new species of *Esperiopsis* from the continental shelf of Queensland, Australia contains spiculation typical of the genus (styles, palmate isochelae and sigmas) in addition to desmas otherwise characteristic of 'Lithistida'. The affinities of the species are discussed, particularly in relation to Topsent's nominal desma-bearing poecilosclerid genera *Desmatiderma* and *Helophloeina*. Those genera are synonymised here with the genera *Euchelipluma* and *Meliiderma* respectively and also referred to Esperiopsidae, and structural and geometric similarities with the Ordovician group *Saccospongia* are noted.

□ *Taxonomy, new species, Porifera, Demospongiae, Poecilosclerida, Esperiopsidae, Esperiopsis, Lithistida, Queensland, continental slope.*

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Recent deep-water collections made along the continental shelf of northeastern Australia, in the vicinity of Flinders Reefs, produced a remarkable poecilosclerid demosponge which contained spiculation typical of Esperiopsidae (viz. styles, palmate isochelae and sigmas) as well as desmas characteristic of Lithistida. The species is described below, and contrasted with other lithistids and esperiopsids. We are grateful to Prof. Michel Pichon (Australian Institute of Marine Science, Townsville) for the opportunity to examine the small collection of deep-water sponges, presently housed in the LBIM at the Paris Museum, and we thank Dr. Charles Webb (University College of the Northern Territory) for assisting with scanning electron microscopy. The holotype is deposited in the Queensland Museum (QM), North Queensland Branch, Townsville. Due to the very small and fragile nature of the specimen we include the coated stubs used in SEM studies in the type-lot deposition. Methods of spicule preparation for light and scanning electron microscopy are described elsewhere (Hooper 1986). Cross-sections through the sponge were examined under SEM untreated, whereby air-dried, preserved sections were mounted directly onto stubs and vacuum coated.

Order POECILOSCLERIDA Topsent, 1928
Family ESPERIOPSIDAE Hentschel, 1923
Genus *Esperiopsis* Carter, 1882

Esperiopsis desmophora n.sp.

MATERIAL EXAMINED

HOLOTYPE: QM G25001, Continental slope, off Townsville, Queensland, Australia, vicinity of Flinders Reefs, 17° 22' 099" S, 147° 48' 27" E, 1187-1210m depth, 11 May 1986, M. Pichon, A. Birtles, and P. Arnold, 'Cidaris I' expedition, stn 24.3, sledge (field number 051).

DESCRIPTION

Morphology: The single specimen has the form of an erect stem with total height of 24mm high and 2mm in diameter. Colour in ethanol is yellow-grey. The sponge body is slightly fusiform, measuring 14mm long, and is fixed to a spiculous pedicel, 8-10mm minimum length, which bifurcates near to the point of attachment with the substrate. Apart from the pedicel the entire surface of the sponge is strongly hispid. The pedicel is solid and friable, composed of a central or axial column of styles loosely surrounded by desmas. This axial column runs throughout the central core of the sponge, and is clearly homologous with the condensed axial skeleton of typical members of the order Axinellida. The distal portion of the sponge body is more flexible. Diverging perpendicular to the axis is a complex radial series of extra-axial bundles of styles. These bundles protrude through the ectosome, forming diverging brushes which produce the prominent hispid appearance of the sponge. Surrounding the axial skeleton, lying in loose tracts in the extra-axial skeleton, and forming a prominent layer on the ectosome are regular or irregular deposits of desmas and microscleres (Fig. 5). The sponge body, i.e. the



FIGS 1-4. Megascleres and microscleres of *Esperioipsis desmophora* n.sp. 1, subtylostyles; 2, desmas; 3, sigma; 4, isochelae.

area bounded by the ectosomal tracts of desmas, comprises approximately 50% of the sponge diameter. Spongin is very scarce and appears to be concentrated around the extra-axial bundles of styles and ectosomal layer of desmas.

Spicules: Structural styles are slightly curved, invariably smooth, with evenly rounded to slightly subtylote bases. The longest styles usually occur in the axial region, measuring between $450-510 \times 8-10\mu\text{m}$, whereas the shortest occur predominantly as subdermal plumose brushes with dimensions $320-420 \times 6-8\mu\text{m}$, but this regional localisation of spicule length classes is not absolutely rigid.

Desmas may vary considerably in morphology (Figs 2, 8-10): most can be characterised as being generally cylindrical, embossed, often bifurcate or trifurcate at one extremity, measuring $320-420 \times 10-20\mu\text{m}$, whereas some are distinctly much shorter. Desma diameter is very irregular, and some have plate-like forms attaining $80\mu\text{m}$ in length (Fig. 9).

Isochelae are palmate, with slightly arcuate tendencies of the alae, possessing well curved wings and large, tapering and sharp teeth: dimensions range from $60-85\mu\text{m}$ (averaging around $70\mu\text{m}$) long.

Sigmas are relatively large, thin, and evenly curved, $30-40 \times 2\mu\text{m}$.

ETYMOLOGY

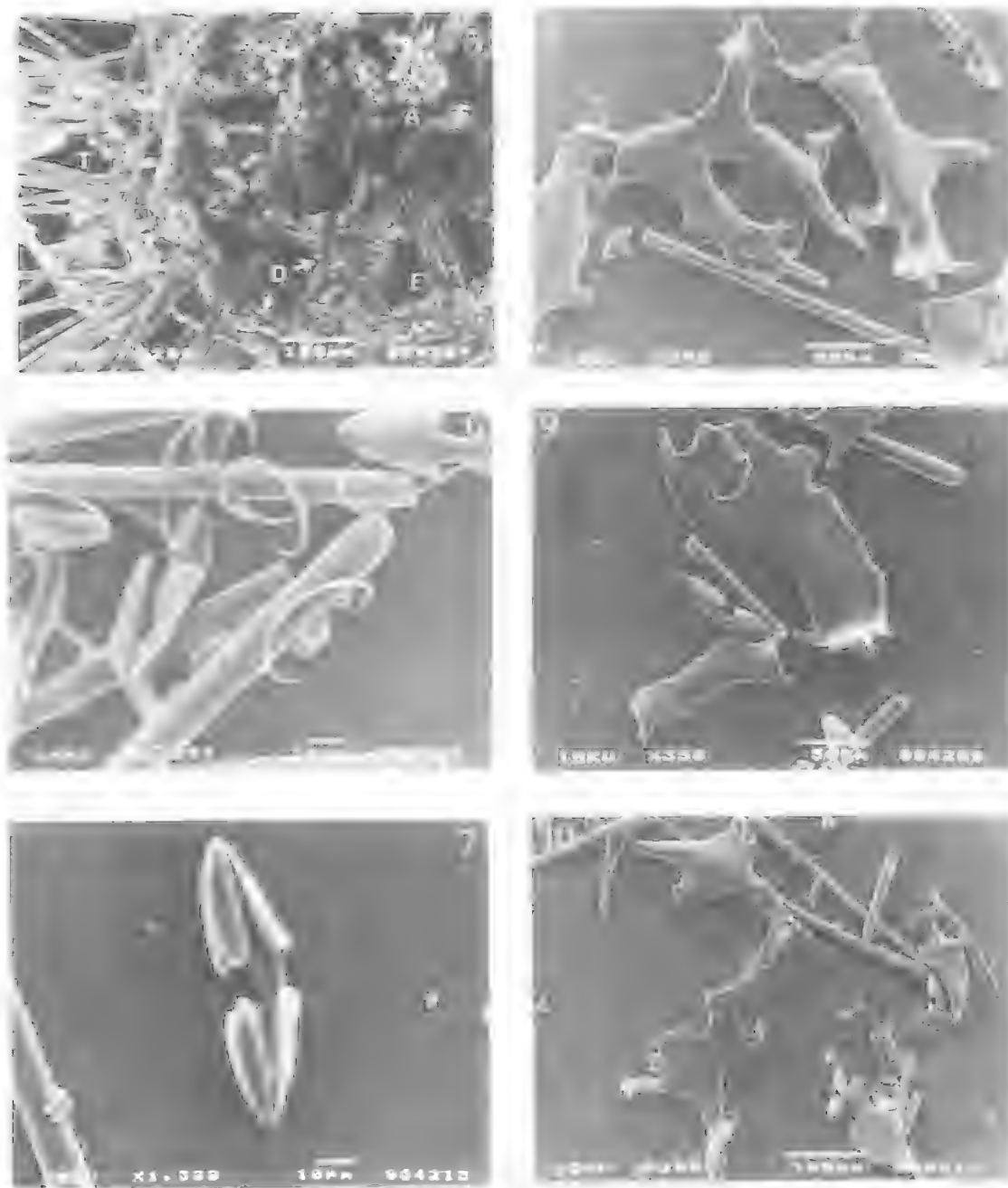
The species is named for the unique possession of desmas.

HIGHER SYSTEMATIC RELATIONSHIPS

In having a skeleton composed of styles, palmate isochelae and sigmas this new poecilosclerid sponge is obviously related to the *Esperiopsidae*, and apart from the presence of desmas the species has characteristics which resemble typical members of the genus *Esperiopsis* Carter. We include *E. desmophora* with that genus, in preference to erecting a new taxon for the species, (and in preference to including it with the polyphyletic order *Lithistida*), since we consider the presence of skeletal desmas is probably an ancestral character, (providing rigidity to an otherwise flexible skeleton) which has been retained in relatively sheltered deep-water taxa, whereas *Esperiopsis*, which have invaded the more turbid shallow-coastal waters, have probably shed their desmas. Two groups of species have been included in the genus *Esperiopsis*. Typical forms, such as the type species *Esperia villosa* Carter, 1874, and the present species, are usually stipitate, erect, sometimes branching, quill-like, and live in deep water. The second group contains atypical species such as *E. fucorum*, *E. normanni* and others, which are massive, live in shallow water, and possess a renieroid skeletal architecture. This feature is considered to have been produced as a response to littoral existence.

Typical *Esperiopsis* (viz. *E. villosa*) has a skeleton composed of tracts of styles forming branches with anastomoses. Initially referred to the *Desmacidonidae* *Mycalinae* by Ridley and Dendy (1887), the group was subsequently placed in section *Protorhabdina*, family *Esperiopsidae* (Hentschel, 1923). That family was supposedly clearly defined by its skeletal architecture, the absence of ectosomal spicules, and in having isochelae and sigmas. However, van Soest (1984) suggested that the group is presently a dust-bin family, containing species with monactinal or with diactinal megascleres; with myxillid-like reticulate skeletons; or with plumo-reticulate skeletal tracts composed of very fine megascleres, and in which megascleres may sometimes become vestigial or even be replaced entirely by sand grains (the latter group fitting with the old concept of *Stylotellinae* Lendenfeld).

The present species, and the genus *Esperiopsis* is returned here to the family *Esperiopsidae*, in preference to using the more widely used group *Desmacididae* Schmidt (or *Desmacidonidae* Gray,



FIGS 5-10. Scanning electron micrographs of *Esperiopsis desmophora* n.sp. 5, cross-section through sponge, showing condensed central or axial skeleton (A), plumose extra-axial skeleton (E) protruding through the axial cover of desmas and the ectosomal layer, and forming radial tufts of spicules (T), and showing choanosomal tracts and a peripheral (ectosomal) layer composed of desmas and microscleres (D); 6, sigmas; 7, palmate isochela; 8-10, desmas.

sensu Bergquist, 1978) (*cf.* van Soest, 1984; Wiedenmayer, 1989). In this restricted sense of Hentschel (1923), *Esperiopsidae* includes only taxa like *Esperiopsis*, *Euchelipluma* Topsent, *Meliiderma* Ridley and Dendy and incrusting species such as *Crambe* Vosmaer, which have megascleres of only monactinal origin and possess clearly delineated axial (or basal) and extra-axial components of the skeleton. In contrast, megascleres of typical *Desmacididae* (*i.e.* *sensu* Levi, 1973; van Soest, 1984), such as *Desmacidon* Bowerbank, *Guitarra* Carter, *Strongylacidon* Lendenfeld and others, are well developed and have obvious diactinal origins, and skeletal structure has a tendency towards reticulate or plume-reticulate patterns. *Desmacidids* associated with the group *Stylotellinae* (including the genera *Stylotella* Lendenfeld, *Tetrapocillon* Brøndsted, and sand-bearing taxa such as *Phoriospongia* Marshall, *Psammoclema* Marshall) have weakly developed skeletal tracts, often approaching a plumose arrangement, with predominantly monactinal megascleres. All three groups (*Desmacididae*, *Stylotellinae*, *Esperiopsidae*) have sigmoid microscleres and isochelae, which may or may not possess structural modifications (*e.g.* *Guitarra* (*cf.* Lee, 1987), *Tetrapocillon* (*cf.* van Soest, 1988), *Meliiderma* (*cf.* Ridley and Dendy, 1887), respectively). In general, both the spiculation and skeletal architecture of typical *Desmacididae* (*e.g.* *Desmacidon*) is suggestive of affinities with the *Myxillidae*, and the group lacks only a specialized ectosomal skeleton of diactinal megascleres (which is apomorphic for the *myxillids*). By comparison, typical *Esperiopsidae* (*e.g.* *Esperiopsis*) appear to have closer structural affinities with the *axinellids* and with some *Myxillidae*.

AFFINITIES BETWEEN DESMA-BEARING SPECIES

Three other desma-bearing *esperiopsid* groups are known: members of the genus *Crambe* (with a basal layer of desmas, a choanosomal and an ectosomal category of subtylostyles, arcuate isochelae, and raphides), *Desmatiderma arbuscula* Topsent, from Sagami Bay, Japan, and *Helophloeina stylivarians* Topsent, from the vicinity of the Canary Is. The latter two are deep-water species, from 1530 and 1340m depth, respectively. Both were assigned to monotypic genera created by Topsent (1928, 1929), *Desmatiderma* and *Helophloeina*, but these species are probably better considered as desma-bearing forms of *Euchelipluma* Topsent and *Meliiderma* Ridley and Dendy, respectively. Topsent assigned those taxa to the

Mycalinae, which was at the time a subfamily of *Desmacidonidae sensu* Ridley and Dendy (1887). *Desmatiderma arbuscula* is an erect ramose sponge, in which the styles are aligned equally along the axis of branches. In the terminal buds of branches styles (and strongly stylized) occur in oblique bundles which form the superficial hispidation. The presence of placochelae, isochelae, sigmancistras and sigmas in that species bring it close to *Guitarra*, *Tetrapocillon* and particularly *Euchelipluma*, of which it is undoubtedly a member. In *Helophloeina stylivarians* in the fragments of the stem, at the point of attachment, there are anisochelae similar to those usually found in *Asbestopluma*, whereas the microstrongyles at the top, which cover the pedicel, resemble those of *Meliiderma*, to which the species should be referred. The skeleton of the present species resembles that of *Desmatiderma* in particular, in which the axial styles are also enclosed in a covering of desmas, of identical morphology, and these data suggest a possible common ancestry for *Esperiopsis* and desma-bearing *Euchelipluma* (or *Desmatiderma*) in particular, and for all those sponges formerly included in Ridley and Dendy's (1887) concept of *Mycalinae* in general.

Similarities between the skeletal architecture of *E. desmophora* and the Ordovician sponge *Saccospongia laxata* Bassler are remarkable (compare Fig. 5 present contribution and text-fig. 1, pl. 145-6, Finks, 1967). The geometry of styles is similar (*cf.* Fig. 6 and Finks, 1967, text-fig. 2); the axis of branches in both species is supported by bundles of longitudinal styles; extra-axial tracts (*viz* the plumose spicule bundles diverging from the axis) cross a covering of desmas which surround the axial skeleton. However, the desmas of *Saccospongia* are very short and their form does not easily convey their origin, whereas those of desma-bearing *Euchelipluma* (or *Desmatiderma*) and the present species have a monaxial origin, which Topsent (1928) suggested were similar to modified styles. Nevertheless, similarities between *E. desmophora* and the Ordovician species are quite marked and more obvious than any differences between them.

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REVISION OF THE GENUS *CARLIA* (REPTILIA, SCINCIDAE) IN AUSTRALIA WITH COMMENTS ON *CARLIA BICARINATA* OF NEW GUINEA

G. INGRAM AND J. COVACEVICH

Ingram, G. and Covacevich, J. 1989 11 13: Revision of the genus *Carlia* (Reptilia, Scincidae) in Australia with comments on *Carlia bicarinata* of New Guinea. *Mem. Qd Mus.* 27(2): 443-490. Brisbane. ISSN 0079-8835.

Skinks of the genus *Carlia* are confined to Australia, New Guinea and some islands of the Indonesian Archipelago, Marianas and the North Solomons. In Australia, there are 21 species. These are: *C. amax* Storr, 1974; *C. coensis* (Mitchell, 1953); *C. dogare* Covacevich and Ingram, 1975; *C. gracilis* Storr, 1974; *C. jarnoldae* Covacevich and Ingram, 1975; *C. johnstonei* Storr, 1974; *C. longipes* (Macleay, 1877); *C. munda* (de Vis, 1885); *C. mundivensis* (Broom, 1898); *C. pectoralis* (de Vis, 1884); *C. rhomboidalis* (Peters, 1869); *C. rimula* Ingram and Covacevich, 1980; *C. rostralis* (de Vis, 1885); *C. rubrigularis* sp. nov.; *C. rufilatus* Storr, 1974; *C. schmeltzii* (Peters, 1867); *C. scirtetis* Ingram and Covacevich, 1980; *C. storri* sp. nov.; *C. tetradactyla* (O'Shaughnessy, 1879); *C. trilucantha* (Mitchell, 1953); and *C. vivax* (de Vis, 1884). The taxa, *foliorum*, *burnetti* and *novaeguineae*, formerly assigned to *Carlia*, have been transferred to *Lygisaurus*, a genus recently resurrected from the synonymy of *Carlia* by Ingram and Covacevich (1988). *C. johnstonei grandensis* Storr, 1974, is a variant of *C. omux* and *C. prava* Covacevich and Ingram, 1975, is a northern variant of *C. schmeltzii*. *C. storri* sp. nov. from northern Queensland and southwestern Papua New Guinea is separated from the Papua New Guinean species *C. bicarinata* (Macleay, 1877), which we redescribe. *C. rubrigularis* sp. nov. is found in the rainforests of northeastern Queensland. A new subspecies of *C. pectoralis*, *C. p. inconnexa*, is found on the islands of the Whitsunday Group, mid-eastern Queensland. To stabilize the nomenclature for the species, we declare lectotypes for *Heteropus sexdentatus* Macleay, 1877, *H. cheverti* Macleay, 1877, *H. quinquecarinatus* Macleay, 1877, *H. rhomboidalis* Peters, 1869, *Lygosoma maccooyi* Ramsay and Ogilby, 1890, *H. lateralis* de Vis, 1885, *H. blackmanni* de Vis, 1885, and *H. albertisii* Peters and Doria, 1878, and neotypes for *H. mundus* de Vis, 1885, *Myophila vivax* de Vis, 1884, and *H. bicarinatus* Macleay, 1877.

□ *Scincidae*, *Reptilia*, *Carlia*, taxonomy, Australia, New Guinea.

Glen Ingram and Jeanette Covacevich, Queensland Museum, PO Box 300, South Brisbane, Queensland 4101, Australia; 22 April, 1989.

In reviewing *Carlia* two major problems have been encountered — the presence of only a few distinctive external morphological characteristics on which species diagnoses may be easily based and confusion about some of the names of taxa described by Charles de Vis.

Storr (1974) has noted that examination of large series of *Carlia* specimens is a prerequisite to distinguishing individual and interspecific variation. Live specimens are more easily identified than preserved specimens because colour and pattern, especially of adult breeding males, are useful distinguishing features. These change or are lost with preservation and, as most of the features conventionally used in external morphology based studies (e.g. midbody, supraciliary scale counts) vary greatly and show zones of overlap between *Carlia* taxa, preserved specimens, particularly old specimens, are frequently difficult to identify. When large series of *Carlia* are examined, including live or freshly preserved specimens, most specimens can be easily assigned to species.

Charles de Vis was associated with the Queensland Museum from 1882 to 1911. He was a prodigious worker (Ingram, 1986) and described many new taxa of frogs and reptiles including nine taxa currently referred to *Carlia* (de Vis 1884a,b, 1885, 1888). Type specimens of half of these are believed to be lost (Covacevich, 1971). Despite the fact that de Vis probably deposited at least most of his material in the Queensland Museum, he did not publish either registration numbers for his specimens or the numbers of specimens on which descriptions were based. The problem of assigning de Vis's taxa to currently recognized species is further complicated by the inadequacy of some of his type descriptions. Boulenger (1885) criticized de Vis's papers, noting 'Their author is no doubt stimulated by the desire of promoting herpetological knowledge in his country, but, through his incompetence and want of care, he will do much harm.' This criticism is too harsh. Facilities for research were inadequate in colonial Queensland (Ingram, in press). In this paper, we attempt to

solve the problem of the identity of several of de Vis's names.

TECHNIQUE

Approximately 2000 specimens held in the following museums have been examined: Queensland Museum, Brisbane (QM); Australian Museum, Sydney (AM); Museum of Victoria, Melbourne (MV); Donald Thomson collection in the Museum of Victoria, Melbourne (MV DT-D); South Australian Museum, Adelaide (SAM); Western Australian Museum, Perth (WAM); Northern Territory Museum of Arts and Sciences, Darwin (NTM); Museum of Comparative Zoology, Harvard (MCZ); British Museum of Natural History, London (BMNH); Zoologisches Museum, Humboldt University, East Berlin (ZMB); Museo Civico di Storia Naturale, Genoa (MSNG); Muséum National d'Histoire Naturelle, Paris (MNHN).

The following body measurements and morphological characters have been used in separating the species:

Distance from snout to vent in millimetres (SV); head width at widest part as % SV (HW); tail length as % SV, excluding specimens with regenerated tails (TL); prefrontals (separated or forming a suture); number of supraciliaries on both sides of head (see Ingram and Covacevich, 1988, for definition of supraciliaries); palpebral disc; size of palpebral disc compared with ear aperture size; shape of ear aperture; size, shape and position of ear lobules; number of midbody scales; mid-dorsal scale shape and carinations; number of lamellae under the left fourth toe (where possible); colour and pattern of juveniles, adult males, and females.

The approach adopted in this study is basically a combination of the 'museum' and 'ecological' species criteria discussed by Crowson (1970). Specimens were first sorted intuitively into groups of like specimens. These groups were considered to constitute species if they could be distinguished by at least two characters from other similar groups. Wherever possible, field observations of each 'species' were used to support or change decisions based on morphological differences. Where we had knowledge of the male breeding colours for the groups we sorted, we hypothesized that these would be important in the specific-mate recognition systems (*sensu* Paterson, 1985), which justified our decision to recognize these as specific taxa.

We did not repeat all of the work of Storr (1974). As this revision progressed, it became obvious that there was no reason to repeat his work

for Western Australian and Northern Territory species except for *Carlia johnstonei*. All the localities given by Storr (1974) are included in the distribution maps in this paper.

Carlia Gray

1845 *Carlia* Gray. 'Catalogue of the specimens of lizards in the collection of the British Museum'. p. 271. Type species by monotypy: *Mocoo melanopogon* Gray, 1845.

1885 *Myophila* de Vis, *Proc. R. Soc. Qd* 1: 77. Type species by monotypy: *Myophila vivax* de Vis, 1884.

DIAGNOSIS

Small to moderately large, ground-dwelling or rock-climbing skinks with four fingers and five toes; body scales of adults usually keeled, tuberculate or carinate but occasionally smooth; body scales of juveniles always keeled, carinate or tuberculate; 4 supraoculars; supraciliaries in an uninterrupted series; two presuboculars with 2 scales between the second presubocular and the nasal; lower eyelid moveable with a transparent disk; prefrontals usually separated but may meet and form a suture; frontoparietals fused to form a single shield (which is fused to the interparietal in *C. rhomboidalis*, *C. rubrigularis* and some New Guinean species); no supranasals; parietals contact behind the interparietal; one pair of enlarged nuchals; and supralabials nearly always 7. Most species are sexually dichromatic with male breeding colours of pink, red, orange, blue, yellow or black distributed usually on the sides of the body and/or throat. Further distinguished from *Lygisaurus* de Vis, 1884, by larger number of supradigital scales on fourth toe (10 or more vs fewer than 10) and lower number of premaxillary teeth (usually 13 vs usually 15) (Cogger, 1986).

DISTRIBUTION

Timor, Moluccas, New Guinea, North Solomons, Marianas and northern and eastern Australia. The genus is essentially an Australian one with an apparent centre of abundance in North Queensland (Storr, 1974). Two species groups (*bicarinata*, *fusca*) also occur outside Australia in the New Guinea-Indonesia region. In eastern and northern Queensland *Carlia* species are a conspicuous element of the ground-dwelling reptile fauna. Near Lankelly Creek, via Coen, north eastern Queensland, for example, six species of *Carlia* (*C. coensis*, *C. rimula*, *C. schmeltzii*, *C. vivax*, *C. longipes*, and *C. storri*) have been collected in a small rocky area of open sclerophyll and closed forest along a seasonally moist gully with a dense leaf litter cover.

REMARKS

Greer (1974, 1975) and Storr (1974) have recently re-defined *Carlia*. Storr's definition is based solely on Western Australian specimens. Mitchell (1953), Arnold (1966), Goldman, Hill and Stanbury (1969), Storr (1974), Cogger and Lindner (1974), Covacevich and Ingram (1975), Greer (1976), and Ingram and Covacevich (1980) and Storr *et al.* (1981) have recently reviewed or described *Carlia* species. In addition, Cogger (1975, 1979, 1983, 1986; Wilson and Knowles, 1988) have reported some preliminary results of this study. Ingram and Covacevich (1988) resurrected the genus *Lygisaurus* from the synonymy of *Carlia* for *Lygisaurus foliorum* and its relatives (*sensu* *C. burnetti* and *C. novaeguineae* of Cogger *et al.*, 1983).

We have not used the new names proposed by Wells and Wellington (1984, 1985) for reasons already explained (Ingram and Covacevich 1988a,b). However, all their names that are pertinent to this revision appear to be either junior synonyms or *nomina nuda* and do not affect valid names. These are *Liburnascincus* (= *Carlia*), *Carlia covacevichi* (= *C. munda*), *C. arafurae* (= *C. gracilis*), *C. boltoni* (= *C. gracilis*), *C. instantanea nomen nudum* (= *C. amax*), *C. monsolgaensis nomen nudum* (= *C. triacantha*), *C. mysteria nomen nudum* (= *C. triacantha*), and *C. springelli* (= *C. munda*).

COMPOSITION

Twenty one species of *Carlia* occur in Australia: *C. amax*, *C. coensis*, *C. dogare*, *C. gracilis*, *C. jarnoldae*, *C. johnstonei*, *C. longipes*, *C. munda*, *C. mundivensis*, *C. pectoralis*, *C. rhomboidalis*, *C. rimula*, *C. rostralis*, *C. rubrigularis* sp. nov., *C. rufilatus*, *C. schmeltzii*, *C. scirtetis*, *C. storri* sp. nov., *C. tetradactyla*, *C. triacantha* and *C. vivax*.

***Carlia amax* Storr**
(Figs 1,2,3)

1974 *Carlia amax* Storr, *Rec. West. Aust. Mus.* 3: 160. Mitchell Plateau, N Western Australia. Holotype WAM R43350.

1974 *Carlia johnstonei grandensis* Storr, *Ibid.* p. 164. Groote Eylandt, NT. Holotype AM R13464 (formerly R13464A).

MATERIAL EXAMINED

WESTERN AUSTRALIA: Stewart River, Kimbolton (WAM R51824, 51831); Kimbolton Spring, Kimbolton (WAM R52639); Prince Regent River National Park (WAM R46823-28, 46964, 47450, 46758-62, 46946-8, 46952, 46958); Mitchell Plateau (WAM R43350); Blythe Creek (WAM R47450);

NORTHERN TERRITORY: Port Darwin (QM J2246); Mandorah, Darwin Harbour (AM R52088); Darwin airport (AM R52089); Casuarina Beach, Darwin (QM J24509); Berry Springs Reserve (NTM 2713); Mt Carr, Adelaide River (AM R52090-3; NTM 1237); 32.5km SE



FIG. 1. *Carlia amax*, Katherine Gorge NP, NT (Steve Wilson).

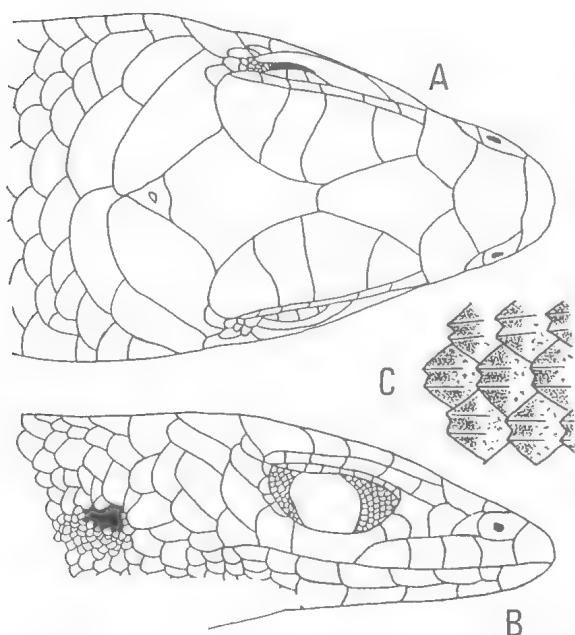


FIG. 2. *Carlia amax* (QM J36729): A, Dorsal view of head. B, Lateral view of head. C. Mid-dorsal body scales.

of Noonamah (NTM 2723, 2728); Robin Falls (NTM 3079); Ban Ban Springs (NTM 3203, 3213-4); Lightning Dreaming Valley, Jim Jim (QM J24515-6); Wollonga Reserve, nr Jim Jim (QM J24517); Pine Creek (QM J23971-2); 75.8km S of Katherine (NTM 1268-9); Katherine (NTM 2172); 6.1km W of Oenpelli (NTM 599); El Sharana (NTM 113-4); Woolwanga Reserve, S Alligator River (AM R41260, 41262); 26.6km SW of Oenpelli (NTM 2655-6); 34.5km SW of Oenpelli (NTM 2645-6); Inyaluk Hill ESE of Oenpelli (NTM 772-4); Radon Creek (QM J36729, 36735-6); Twin Falls, Kakadu NP (QM J36738-40); Mt Brockman (NTM 2412-17, 2499-501, 2961, 3001); 150km N of Dunmarra (NTM 1773); Maningrida Settlement (AM R41927, 41935); 88.5km S of Larrimah (AM R52094); Milingimbi, Crocodile Island (MV D1243); Groote Eylandt (AM R13464, 13607, 54705, 55684); Observation Island, Pellew Group (AM R8121); Cape Arnhem (AM R13585-6, 47171-6; MV DT-D242-5); 5 km N of Borroloola (QM J37188); 3.7km N of McArthur River camp on Borroloola Road (AM R53444); 36.5km N of McArthur River camp on Borroloola Road (AM R53365-7);

QUEENSLAND: Mornington Island (QM J28704); Moonlight Creek, 60 km N of Doomadgee (QM J47790); 42 km W of Mt Isa (QM J42491); Mica Creek, via Mt Isa (QM J43262); Mt Isa (QM R17973); 15 km W of Cloncurry (QM J42079).

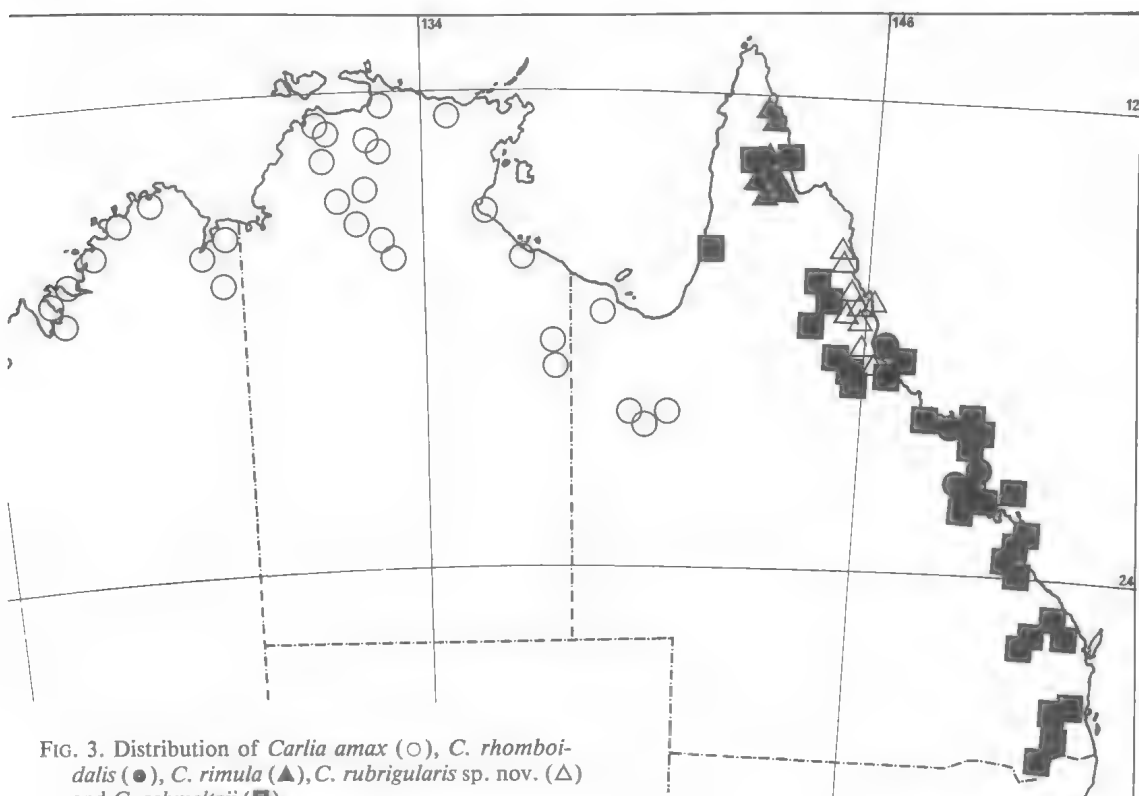


FIG. 3. Distribution of *Carlia amax* (○), *C. rhomboidalis* (●), *C. rimula* (▲), *C. rubrigularis* sp. nov. (△) and *C. schmeltzii* (■).

DIAGNOSIS

A very small (maximum SV 38) *Carlia* with bicarinate and hexagonally shaped mid-dorsal scales and with longer axis of ear aperture horizontal. Distinguished from *C. johnstonei* by smaller ear aperture, fewer, more obtuse lobules and fewer supraciliaries (usually 6 vs 7), and from *C. vivax* and *C. dogare* by more numerous supraciliaries (usually 6 vs 5).

DISTRIBUTION

Far north Western Australia south to latitude 16°30'S; also Heywood, Wood, and Koolan Islands. Far north and north east Northern Territory, south to the watershed between Gulf of Carpentaria and the Barkley Tableland to north-west Queensland; also Groote Eylandt, Maria, Craggy and Observation Islands in the western part of the Gulf of Carpentaria and Mornington Island (see Storr, 1974).

DESCRIPTION

SV: 24-38 (N = 9, mean 34). HW: 14-17 (N = 9, mean 16). TL: 144 (N = 1).

Prefrontals separate. Supraciliaries usually 6 (73%) sometimes 5 (N = 18, mean 5.7). Palpebral disc large. Ear aperture smaller than palpebral disc, longer axis horizontal, usually with a small lobule on anterior margin and occasionally small lobules on other margins. Midbody scale rows 28-32 (N = 9, mean 30.6); mid-dorsal scales strongly bicarinate and hexagonally shaped. Lamellae under fourth toe 25-29 (N = 5, mean 26.2).

Dorsally, laterally, and legs, olive brown, often with dark brown and whitish spotting, and often with dark brown edging to upper and lower labials, and sides of throat; sometimes with chin and throat scales edged in dark brown. Most specimens have a pale top edge to the subocular.

For description of Western Australian and Northern Territory specimens, see Storr (1974: 161).

HABITAT

'*C. amax* is found mainly in rocks especially laterite. It has been collected in spinifex and in leaf litter of deciduous vine thickets growing at the foot of limestone outcrops and sandstone cliffs' (Storr, *in litt.*).

REMARKS

Storr (1974) described *C. amax* and *C. johnstonei grandensis*, basing the latter on two specimens from Groote Eylandt. He distinguished *C. j. grandensis* from the former by its much darker coloration, especially of the throat, chin, and flanks,

and by its greyish white flecking on the sides, but he did not separate them on morphological characters. He also noted that other than in coloration, these two taxa were more like each other than *C. j. grandensis* was like its nominate subspecies. The Mornington Island specimens in the South Australian Museum examined here showed both *C. amax* and *C. j. grandensis* colouring, as well as intermediates between these two extremes. SAM R5330a, R5379c-d, R5398 are olive brown with no marking; R5379a is similar but with some dark brown edging to the sides of the throat; R5330b has the same ground colour but with grey-white and dark brown spotting dorsally and laterally, and dark brown edging to the upper and lower labials and sides of throat; R5384b is similar but with less grey-white spotting, and the throat and chin scales are edged in dark brown. We could not differentiate these specimens on meristic or morphological characters from each other or from mainland *C. amax*. A recently collected series of *C. amax* in the Australian Museum from the McArthur River area, NE Northern Territory showed similar variation. Two specimens (AM R53444 and R53365) have black lined chin and throat scales.

Taking all these factors into account, we regard *C. j. grandensis* a junior subjective synonym of *C. amax*. The paratype of the former (R13464b) has been re-registered as R55684 and the holotype which bore the number R13464a, is now R13464.

Carlia bicarinata (Macleay)

(Figs 4, 5, 6)

1577 *Heteropus bicarinatus* Macleay. *Proc. Linn. Soc. N.S.W.* 2: 68. Syntypes missing, from Hall Sound, New Guinea. Neotype here designated, QM J27717 from Kairuku, Yule Island, Hall Sound, Papua New Guinea.

1578 *Heteropus albertisii* Peters and Doria. *Ann. Mus. Civ. Genova*. 13: 362. Yule Island, New Guinea. Lectotype MSNG 28052a (here designated).

MATERIAL EXAMINED

PAPUA NEW GUINEA: Yule Island (QM J27717-9; MCZ 142451, 142454-5; MSNG 28052a-e, 28053); Laloki River, Port Moresby (AM R13853, 14577, 14580, 14606-8, 14628); Port Moresby (AM R10916, 24314-8); Mt Diamond, Central Province (QM J30038-9, 30054, 32846, 32849); Konedobu, Port Moresby (QM J30040-2, 32891); Idlers Bay, 6 km W of Port Moresby, Central Province (QM J30043-5, 32865); Taurama Beach, Central Province (QM J32853-4); Waigani, Port Moresby (J32916, 32922, 32926, 34955-61, 34668-72, 34709-14, 34726-9); Maitaku, Port Moresby (J32930-1, 32934, 32940, 32952, 34623-7, 34663-7, 34673-7, 34704-8); no data (AM R935-8; QM J13974, 13977, 13981, 13990-1, 13993).



FIG. 4. *Carlia bicarinata*, Koki, Port Moresby, PNG (Steve Wilson).

DIAGNOSIS

A small (maximum SV 48) ground-dwelling *Carlia* with strongly bicarinate and hexagonally shaped mid-dorsal scales. Ear aperture with short to long acute lobules around margin. Further distinguished from the Timorese *C. spinauris* (data from Greer, 1976) in having more numerous lamellae under fourth toe (24-31 vs 21-25) and dorsal and lateral scales bicarinate (vs tricarinate). Distinguished from *C. mundivensis* by fewer supraciliaries (usually 6 or 5 vs 7) and fewer midbody scale rows (28-33 vs 34-43). For difference from *C. johnstonei* and *C. storri*, see diagnoses of these species.

DISTRIBUTION

Southeast Papua New Guinea, to the northwest and east of Port Moresby. Apparently restricted to the coastal savannahs. Also Yule Island.

DESCRIPTION

SV: 32-48 (N = 94, mean 40.9). HW: 13-17 (N = 94, mean 15.0). TL: 166-232 (N = 42, mean 202.0).

Prefrontals separate. Supraciliaries 6, commonly 5, and rarely 7 (N = 170, mean 5.7). Palpebral disc small. Ear aperture round, usually smaller but sometimes equal to palpebral disc, with short to long acute lobules around margin. Midbody scale rows 28-33 (N = 90, mean 29.4); mid-dorsal scales strongly bicarinate and hexagonally shaped. Lamellae under fourth toe 24-31 (N = 91, mean 27.4).

Colour and pattern varies between two extremes describe below. Females and juveniles with dark

brown base colour with well defined white mid-lateral and dorsolateral lines, two pale brown paravertebral lines enclosing a dark vertebral stripe, and a dark laterodorsal line between the paravertebral line and the white dorsolateral line. Breeding

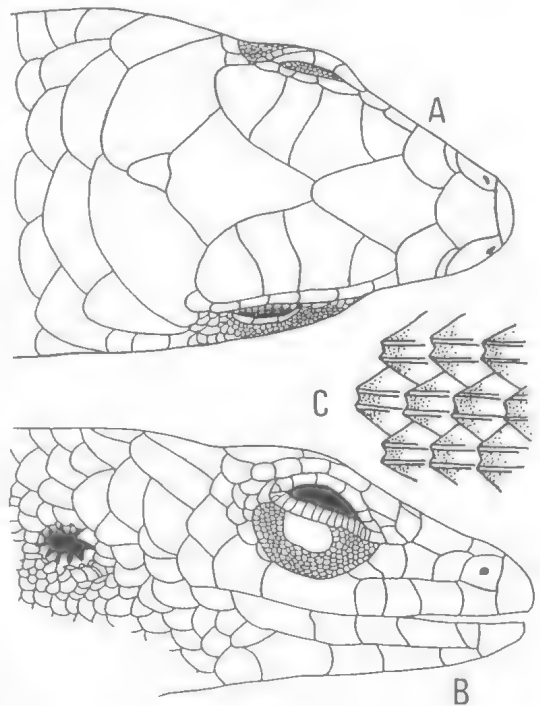


FIG. 5. *Carlia bicarinata* (QM J27717): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

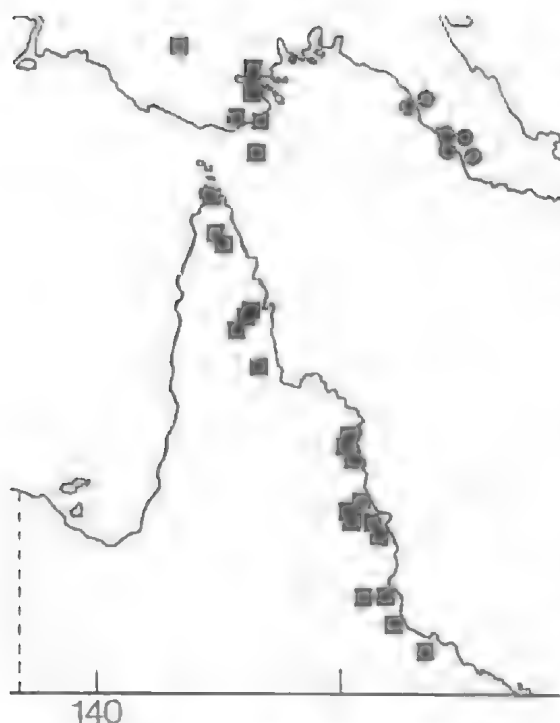


FIG. 6. Distribution of *Carlia bicarinata* (●) and *C. storri* sp. nov. (■).

male heavily spotted with dark brown and with white flecking on body, limbs, and tail; reddish tinge to flanks; labials, side of throat, and under side of head and neck lined in dark brown; a dark line from nares through eye to above ear. Underside white.

HABITAT

Grassy areas in open *Eucalyptus* forest and woodland. Mostly lowlands, but also occurs on the Sogeri Plateau at 550 metres. (F. Parker, pers. comm.).

REMARKS

Goldman *et al.* (1969) could not locate the syntypes of *Heteropus bicarinatus* Macleay. Even so Macleay's short type description can easily be related to an adult male of this species. Ogilby (1890) described and compared specimens from the St Joseph's River District with the types of *bicarinatus*. He was satisfied they were conspecific, and that some specimens were intermediate between the two forms that were described as *bicarinatus* and *albertisii*. Through the courtesy of Dr L. Capocaccia, Museo Civico di Storia Naturale, we were able to examine two syntypes of *Heteropus albertisii* Peters and Doria. These are

an adult male MSNG 28052a (from the syntypic series 28052a-e from Yule Island) and a juvenile from a series of three syntypes from Yule Island (registered under the number 28053). There is another syntype from Mt Epa registered under this number that we did not examine. MSNG 28052a has been selected as the lectotype and thus the type locality for *albertisii* is restricted to Yule Island. To stabilize the nomenclature, we have selected a neotype for *Heteropus bicarinatus* Macleay, 1877, from within the original type locality of 'Hall Sound'.

Neotype: QM J27717 (formerly MCZ 142453) Kairuku, Yule Island, Hall Sound, Papua New Guinea (8°50'S, 146°32'E) collected by F. Parker on 2 November, 1973.

SV: 43. HW: 16. TL: 216.

Prefrontals separate. Supraciliaries 6. Palpebral disc small. Ear aperture round, smaller than palpebral disc, with short to long acute lobules around margin. Midbody scale rows 30. Mid-dorsal scales strongly bicarinate and hexagonally shaped. Lamellae under fourth toe 26.

Heavily spotted with dark brown, and with white flecking on body, limbs, and tail; labials and scales on side of neck lined in dark brown; a dark line from nares through eye to above ear. Underside cream.

C. bicarinata is usually listed as occurring in Australia (e.g. Cogger *et al.*, 1983; Ingram and Covacevich, 1981). However, the specimens belong to distinct taxon, which is similar to *C. bicarinata* (see *C. storri* sp. nov.).

Carlia coensis (Mitchell)

(Figs 7, 8, 9)

1953 *Leiopisma coense* Mitchell. *Rec. S. Aust. Mus.* 11: 82. Coen, NE Queensland. Holotype MCZ 37171.

MATERIAL EXAMINED

QUEENSLAND: Leo Creek, 56 km NE of Coen (QM J32513-4); Leo Creek Goldmine, 30 km NE of Coen (AM J37434); Steene's Hut, 30 km NE of Coen (QM J34499); Steene's Grave, 2 km E of Birthday Mountain (QM J37438); Peach Creek, 19 km ENE of Mt Croll (QM J37437); Weather Station, 19 km ENE of Coen (QM J37435, 37440); 12 km NW of Coen (QM J37439); Coen River, 10 km NE of Coen (QM J37428-31); Lankelly Creek, 10 km NE of Coen (QM J37432-5); Rocky River (AM R16327, 16332, 16294); Upper Lankelly Creek, 16 km E of Coen (McIlwraith Range (QM J21392-3); Lankelly Creek, Coen (QM J23405-7); Coen (MCZ 37170-1); 3 km SW of Coen (QM J37436); 13 km S of Coen (QM J26297).

DIAGNOSIS

A very large (maximum SV 68) *Carlia* with



FIG. 7. *Carlia coensis*, 13km S of Coen, NEQ (David Knowles).

smoothly curved posterior edges to the mid-dorsal scales; dorsal and lateral scales with 3-5 weak carinations with each keel broken up into a series of 2-4 smaller points; ear aperture vertically elongate with small rounded lobules on margins; and with markedly dark and light patterned juveniles. For differences from *C. rimula* and *C. scirtetis*, see diagnoses of these species.

DISTRIBUTION

Known only from the McIlwraith Range and Table Range between Coen and the Pascoe River, Cape York Peninsula, Queensland.

DESCRIPTION

SV: 29-68 (N = 26, mean 44.9). HW: 16-20 (N = 25, mean 17.7). TL: 149-169 (N = 10, mean 163.7).

Prefrontals separate, rarely forming a suture along midline. Upper ciliaries are enlarged forming a ciliary hood over the eye. Supraciliaries 7, rarely 6 or 8 (N = 52, mean 7.0). Palpebral disc small. Ear aperture usually equal to palpebral disc, longer axis vertical, with small rounded lobules around margin. Midbody scale rows 36-45 (N = 24, mean 39.8); mid-dorsal scales with smoothly curved posterior edges; dorsal and lateral scales have 3-5 weak carinations with each keel broken up into a series of 2-3 smaller points; head scales usually rugose. Lamellae under fourth toe 28-37 (N = 25, mean 33.2).

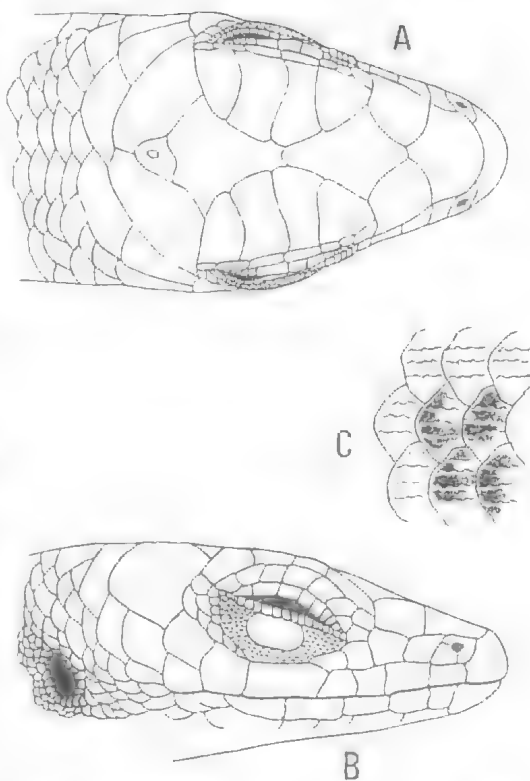


FIG. 8. *Carlia coensis* (QM J23405): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

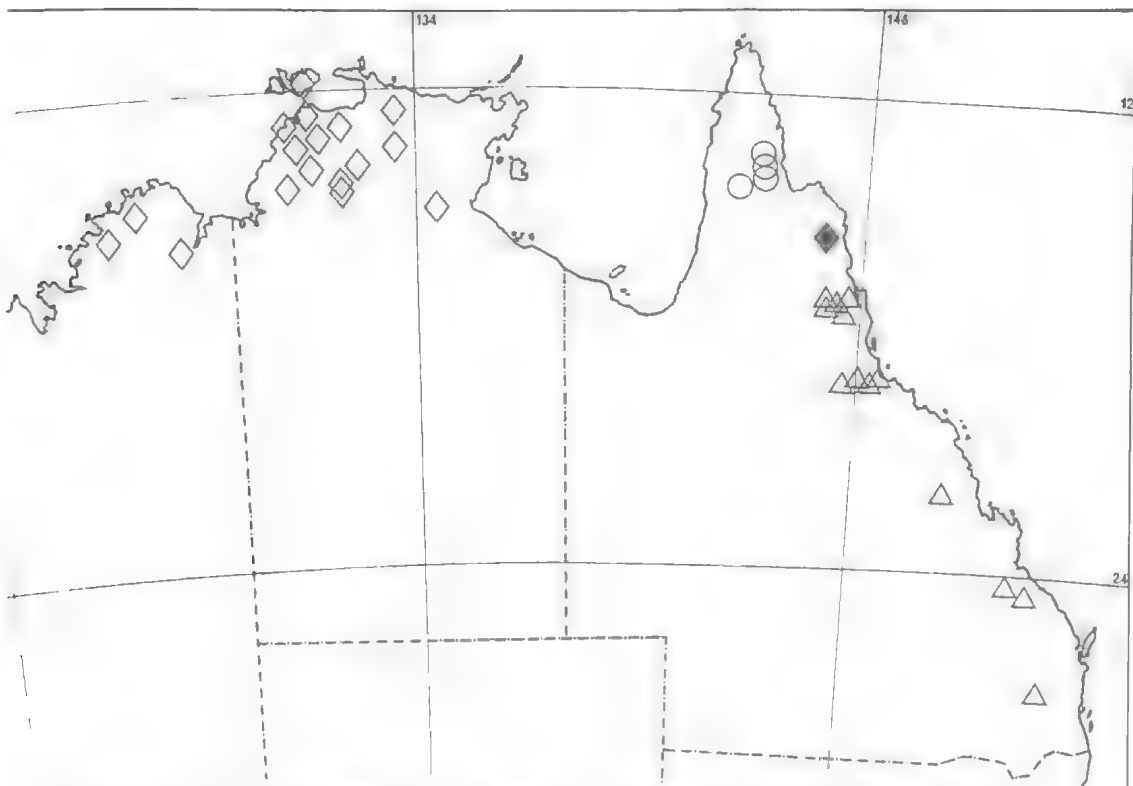


FIG. 9. Distribution of *Carlia coensis* (○), *C. gracilis* (◇), *C. mundivensis* (Δ) and *C. scirtetis* (◆).

Dark brown ground colour, with well defined golden or silver wavy dorsolateral, vertebral, and midlateral lines usually broken up into distinct dashes which continue on to the limbs; dorsolateral lines continuing along tail. Head coppery brown; ear aperture pale edged. In adults this pattern becomes less obvious and some individuals are completely dark brown or black. Underside pale, greyish white to greenish white; feet black.

HABITAT

C. coensis has been collected only from rocks and boulders, or in leaf-litter nearby, in open forest and along creeks in vine-forest.

REMARKS

Carlia coensis is one of six species of lygosomid skinks restricted to bare rocky habitats in Queensland. Three other species of *Carlia* (*C. mundivensis*, *C. rimula* and *C. scirtetis*) also occur only in rocky habitats. All these species have certain morphological and behavioural characteristics in common, which have been summarized and discussed briefly elsewhere (Covacevich and

Ingram, 1978, 1980). Covacevich, Ingram and Czechura (1982) concluded that *C. coensis* was a rare species.

Cogger (1983, fig. 580) has a photograph of a specimen from the Pascoe River, Cape York, which we have not examined.

Carlia dogare Covacevich and Ingram (Figs 10,11,12)

1975 *Carlia dogare* Covacevich and Ingram. *Vic. Nat.* 92: 21. 5-6 km N of the mouth of McIvor River, N Queensland. Holotype QM J20557.

MATERIAL EXAMINED

QUEENSLAND: Bathurst Head (QM J42494); Lizard Island (AM R37196-7, 37211; QM J20436-46, 20451-55, 27309); Eagle Island (AM R6951); Cape Flattery (QM J20749-50); 1.6 km N of the mouth of McIvor River (WAM R45612; QM J20545-8, 20617-9, 20643); 3.2 km N of the mouth of McIvor River (QM J20572); 6.4-8 km N of the mouth of McIvor River (QM J20556-63, 20622-6); N of mouth of McIvor River where Mission road enters beach (QM J32360, 32379, 32387, 32393-5, 32403-4, 32412-20); at beginning of Mission road near Starcke Station (QM J32387).



FIG. 10. *Carlia dogare*, Lizard Island, NEQ (Queensland Museum).

DIAGNOSIS

A small (maximum SV 50) *Carlia* with hexagonally shaped and mostly bicarinate mid-dorsal scales; ear aperture vertically elongate usually with larger rounded anterior lobules. Further distinguished from *C. vivax* in having a larger black ear aperture, more ear lobules (usually 2 vs 1) high lamellae count under fourth toe (usually 29 or more vs usually 28 or less) and by juvenile, female, and male breeding colouring and pattern. Distinguished from *C. schmeltzii* by fewer supraciliaries (usually 5 vs 7), from *C. pectoralis* by its lighter colouring, black ear, high lamellae count under fourth toe (usually 29 or more vs less than 29) and female and juvenile colouring. Distinguished from *C. amax* by fewer supraciliaries (usually 6 vs 5) and in having longer axis of ear aperture vertical.

DISTRIBUTION

Sand dune country from the mouth of the McIvor River north to Bathurst Head, and Eagle and Lizard Islands, Cape York Peninsula, Queensland.

DESCRIPTION

SV: 21-50 (N = 48, mean 41.1). HW: 13-18 (N = 45, mean 16). TL: 148-217 (N = 22, mean 173).

Prefrontals separated. Supraciliaries 5, rarely 4 or 6 (N = 47, mean 5.1). Palpebral disc large, occupying much more than half of lower eyelid.

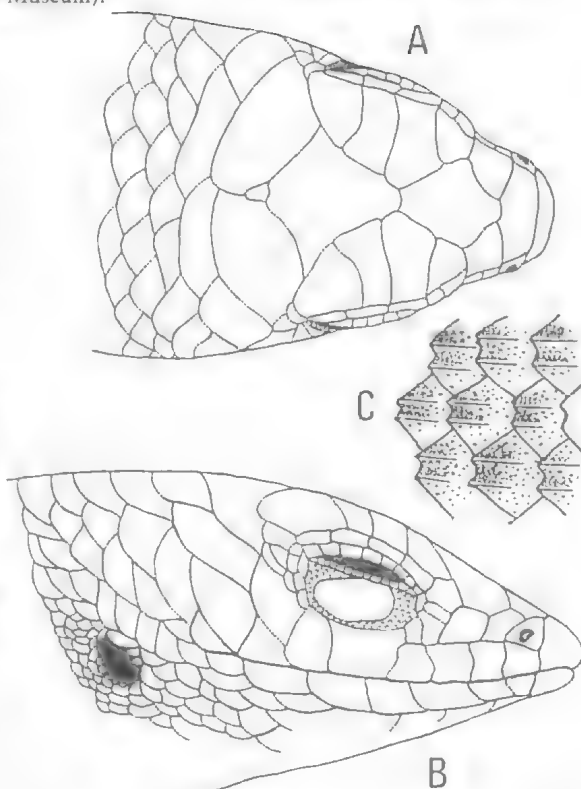


FIG. 11. *Carlia dogare* (QM J20556): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

Ear aperture smaller than disc, longer axis vertical, with 2 lobules (rarely 1 or 3) on anterior margin, upper one larger and more obtuse compared to lower lobule. Midbody scale rows 29-35 ($N = 45$, mean 31.3); mid-dorsal scales angular, usually bicarinate, infrequently tricarinate. Lamellae under fourth toe 26-35 ($N = 45$, mean 31.3).

Ear aperture and margins black. In juveniles and females, head bronze-brown; pale line from nostril along upper labials and under eye; indistinct pale vertebral and dorsolateral lines enclose a series of pale spots with black anterior borders on a brown

background from neck to tail; pale lateral line; legs dorsally brown with white flecking; under surfaces white. In breeding male, uniform brown dorsally and laterally with a grey wash; two orange lateral stripes, the upper beginning above foreleg and finishing above hindleg, the lower from foreleg to just in front of hindleg; and two pink paravertebral stripes. In all phases, there is a white spot at the posterior base of the thigh which sometimes is part of a white line extending along the thigh. Ventrally white.

HABITAT

Heaths and low woodland growing on Quaternary sands.

REMARKS

Little is known of this lizard which has apparently a very restricted range. Covacevich *et al.* (1982) concluded that it was a rare species. Like the sand form of *Ctenotus spaldingi*, it has a bluish appearance in preservative.

Carlia gracilis Storr

(Figs 9, 13, 14)

1974 *Carlia gracilis* Storr, *Rec. West. Aust. Mus.* 3:158. Mitchell Plateau, Western Australia. Holotype R43219.

MATERIAL EXAMINED

WESTERN AUSTRALIA: Mitchell Plateau (WAM); NORTHERN TERRITORY: Reynolds River (AM R52112, 52122-4); near Empire Springs, Reynold River area (AM R52125-7); Rabbit Springs, Reynold River area (AM R52128-9); Darwin (AM R20222, 20225); near East Point, Darwin (AM R52202-6); Mandorah, Darwin Harbour (AM R52107, 52110, NTM 2681-8); Milner, Darwin (NTM 137); Larrykea, Darwin (NTM 2085); Rapid Creek, Darwin (NTM 3122-3); Ludmilla, Darwin (NTM 3409); Casuarina Beach (J23529-30); Berry Springs (NTM 2711-2, 2841, 3003, 3308-11); Howard Springs (NTM 261, 263; QM J24514); Mt Carr, Adelaide River (NTM 1233-4, 1236, 1244-54, 1967); Robin Falls, 16km S of Alligator River (NTM 3077-8); Adelaide River Township (AM R52119-21); 32.5km SE of Noonamah (NTM 2721-2, 2724-7, 2729-30); Hayes Creek, Stuart Highway (NTM 3116); Ban Ban Springs (NTM 3130-2, 3134-5, 3202, 3215); Claravale (NTM 21-4); Wildman River near Junction of West Branch (AM R52113-8); 26.6km SW of Oenpelli (NTM 2657); Oenpelli (NTM 813).

DIAGNOSIS

A very small (maximum SV 41), slender *Carlia* with tricarinate and hexagonally shaped mid-dorsal scales and with longer axis of ear aperture usually horizontal. Further distinguished from *C.*



FIG. 12. Distribution of *Carlia dogare* (♦) and *C. vivax* (■).

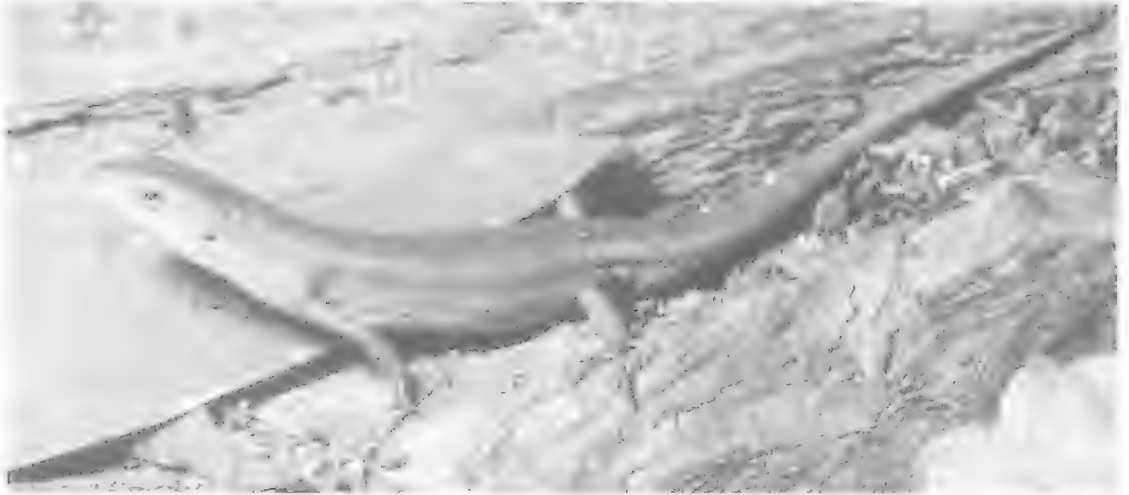


FIG. 13. *Carlia gracilis*, UDP Falls, NT (Steve Wilson).

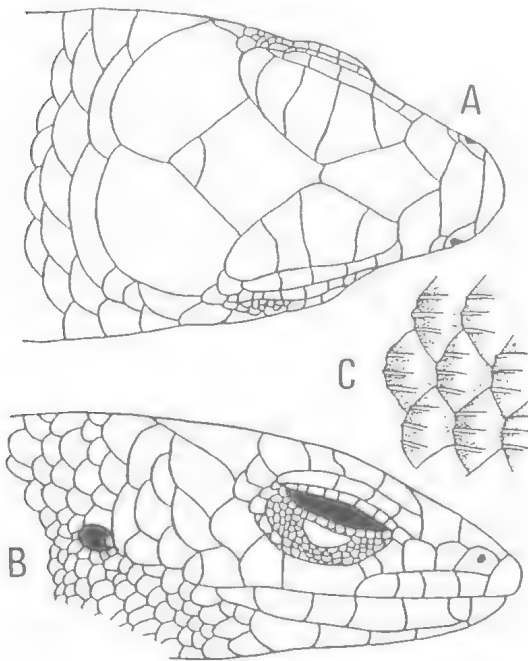


FIG. 14. *Carlia gracilis* (QM J24514): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

pectoralis, *C. munda*, *C. rufilatus*, and *C. jarnoldae* by its smaller palpebral disc (about half of eyelid vs much more than half of eyelid) and from *C. rufilatus* and *C. jarnoldae* in having fewer supraciliaries (usually 5 vs 6 or 7), and from these and *C. munda* in lacking a white stripe from under the eye to the ear.

DISTRIBUTION

Northern Western Australia and Northern Territory. North Kimberley, south to Mitchell Plateau and east nearly to Wyndham; far northern Northern Territory, south to Roper River; also Melville Island (Storr, 1974).

DESCRIPTION

See Storr (1974: 158).

HABITAT

'*C. gracilis* has a strong preference for the leaf litter of closed vegetation, e.g., monsoon forest, coastal thickets and waterside vegetation' (Storr, *in litt*).

Carlia jarnoldae Covacevich and Ingram (Figs 15,16,17)

1975 *Carlia jarnoldae* Covacevich and Ingram. *Vic. Nat.* 92: 19. Wakooka Outstation, Starcke Station, NE Queensland. Holotype QM J20739.

MATERIAL EXAMINED

QUEENSLAND: 18 km NE of Wenlock River crossing on Iron Range road (AM R94090-1); Nichol River Crossing (QM J24668-9); 5 km W of Rokeby Homestead (QM J23443-8); 46 km N of Coen (AM R38499, 38660-3); 3 km N of Coen (QM J26274); 17 km E of Coen (AM R16344-5, 16461-2); Coen (AM R16519-21, 16545-8, 21342); Flinders Island (AM R11077a-c); Melville Range (QM J20513); Wakooka Outstation (QM J20543, 20738-9, 20760-1, 20765); 22.5 km N of Musgrave (AM R38656-9); 11 km NE of Musgrave Station on Marina Downs Road (QM J23621-2); Isabella Falls, 32 km NW of Cooktown (QM J17821); 17 km NW of Cooktown (QM J17821); 14 km W, 3 km N of Cooktown (MV D13714);

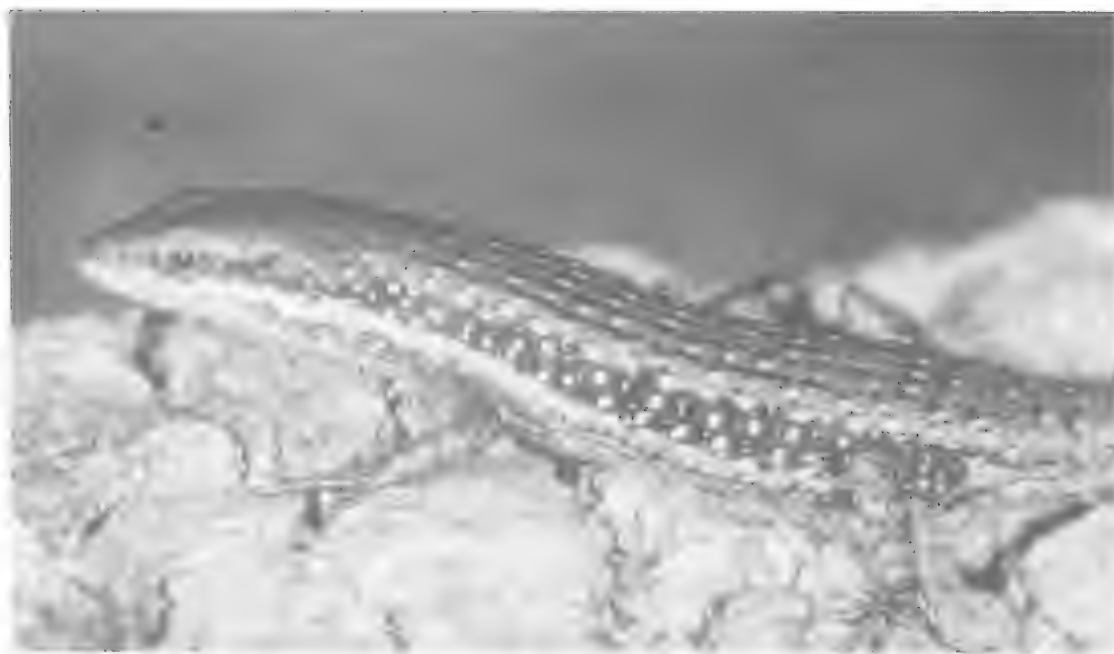


FIG. 15. *Carlia jarnoldae*, locality unknown (Queensland Museum).

Cooktown (QM J24347); Endeavour River (SAM R9737a-c); Laura River, Laura (MV D10259); Palmer River headwaters via Cooktown (QM J25987); Mt Molloy (QM J19407-8, 19411; WAM R45610); Oaky Creek, 11 km W of Cairns (MV D13916); Davies Creek (AM R28463); 8 km N of Tinaroo Dam (QM J12230, 14030-3); Walkamin (QM J26693); Chillagoe area (QM J18036-7); Tinaroo Dam (QM J11843); Stannary Hills (QM J7782-4); 8 km W of Lappa Junction (AM R16449-50); Brownville Battery near Mt Garnet (AM R21319); St Ronans (AM R47141); Mengala Range (NTM 8917); Mt Elliot foothills (QM J25367-8); 36.3 km SE of Townsville (QM J26638-9); 41.8 km SE of Townsville (QM J26663); 50.3 km NE of Charters Towers (QM J23464, 26592-4); 'Brisbane' (QM J1707, 1710).

DIAGNOSIS

A small (maximum SV 49) *Carlia* with hexagonally shaped and moderately tricarinate mid-dorsal scales; ear aperture horizontally elongate. Further distinguished from *C. pectoralis*, *C. munda* and *C. vivax* by colouration and pattern, and by more numerous supraciliaries (usually 7 vs 5). For differences from *C. rufilatus* see the diagnosis of that species.

DISTRIBUTION

NE Queensland from latitude 12°45'S to south of Townsville to latitude 20°S; west to Rokeby Station, near Coen, and the western slopes of the Atherton Tablelands. Also Flinders Island, Princess Charlotte Bay.

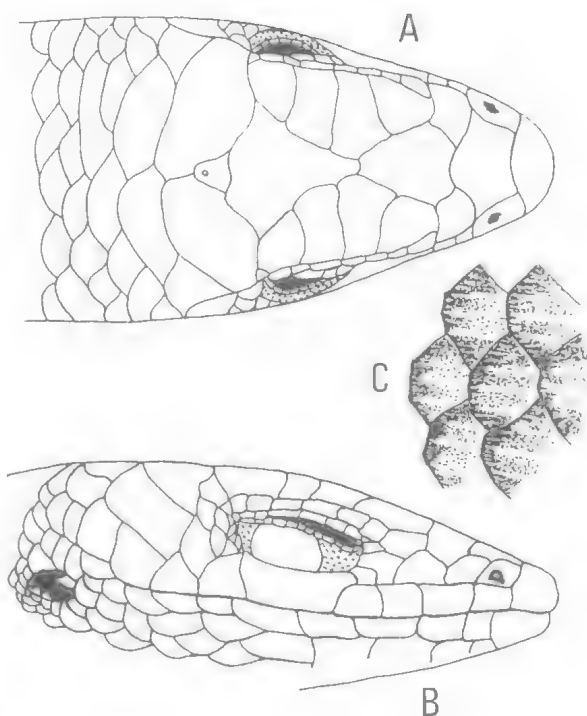


FIG. 16. *Carlia jarnoldae* (QM J26274): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

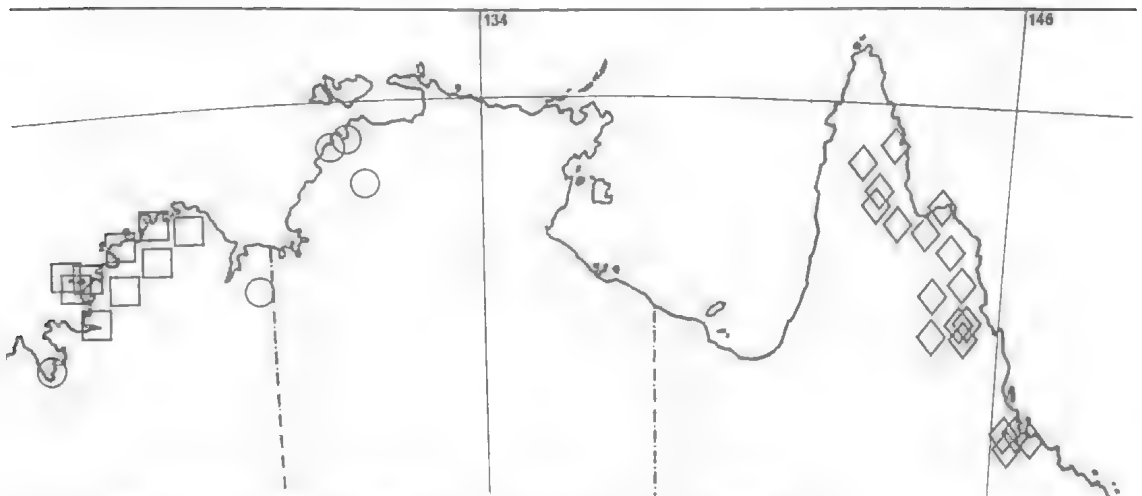


FIG. 17. Distribution of *Carlia jarnoldae* (◇), *C. johnstonei* (□) and *C. rufilatus* (○).

DESCRIPTION

SV: 18-49 (N = 87, mean 38.0). HW: 12-21 (N = 75, mean 17.0). TL: 136-182 (N = 15, mean 157.0).

Prefrontals mostly separate but touching or forming a narrow suture in 9% of specimens. Supraciliaries mostly 7 in the northern part of its range and mostly 6 in the southern part, rarely 8 or 9 (N = 175, mean 6.8). Palpebral disc large. Ear aperture smaller than palpebral disc, longer axis usually horizontal, with a small pointed lobule on anterior margin and smaller ones on other margins. Midbody scale rows 26-33 (N = 82, mean 29.2); mid-dorsal scales hexagonally shaped and moderately tricarinate. Lamellae under fourth toe 22-31 (N = 80, mean 26.1).

Colour and pattern varies between two extremes described below for female and juvenile, and breeding male. In female and juvenile, head

bronze-brown, back and side olive-grey, with a well defined white line edged in black from under eye, through ear aperture, back above foreleg and terminating just in front of hindleg. In breeding male, 5-7 dark blue stripes on a brown background from neck to hindlegs where they break up into spots. The stripes lie between two parallel lines formed by the outer keels of adjacent scales. A thick dark blue stripe flecked with white runs from behind ear to front of hindleg; below this blue stripe there is a red stripe which begins above foreleg and terminates in front of hindleg. A light line starts under eye, passes through, and includes ear, and terminates above foreleg. Undersurface of all specimens white.

HABITAT

Grassy areas in woodland, open forest, and rock ridges. Also rocky dry beds and banks of creeks.



FIG. 18. *Carlia johnstonei*, Manning Ck, WA (Steve Wilson).

***Carlia johnstonei* Storr**
(Figs 17,18,19)

1974 *Carlia johnstonei johnstonei* Storr. *Rec. West. Aust. Mus.* 3: 162. Mitchell Plateau, Western Australia. Holotype WAM R43170.

MATERIAL EXAMINED

WESTERN AUSTRALIA: Mitchell Plateau (QM J23977-8; WAM R43170); Prince Regent River National Park (WAM R46848-9, 46876, 46991, 47003, 47007); Drysdale River National Park (WAM R50523, 50537, 50637, 50758, 50875-6, 50975).

DIAGNOSIS

A very small (maximum SV 43) *Carlia* with bicarinate and hexagonally shaped mid-dorsal scales and with ear aperture margined with pointed lobules. Distinguished from *C. storri*, *C. bicarinata* and the Timorese *C. spinauris* (data from Greer, 1976) by its more numerous supraciliaries (usually 7 vs usually 6), more numerous midbody scale rows (mostly 34-38 vs 27-33, 28-33, 29-33 respectively) and by its fewer lamellae under fourth toe from *C. storri* and *C. bicarinata* (20-26 vs usually 27-34, 28-33 respectively), and from *C. mundivensis* by smaller size (maximum SV 43 vs

56) and lacking the depressed snout of *mundivensis* (Mitchell, 1953, fig. 2). (Mitchell's figure is wrongly labelled (*coensis*) and the captions of figure 1 (which is labelled *vertebralis* = *mundivensis*) and 2 should be reversed).

DISTRIBUTION

Sub-humid north-west coast of the Kimberley Division and adjacent plateaux and continental islands, north Western Australia (Storr, 1974).

DESCRIPTION

See Storr's (1974: 163) description of *C. j. johnstonei*.

HABITAT

'*C. johnstonei* is the *Carlia* of islands and coasts of the wetter parts of northwest Kimberley. It is especially associated with the monsoon forests of basalt country, but is also found in the leaf litter of other kinds of closed or dense vegetation. With *Cryptoblepharus megastictus* it can be found very close to the sea' (Storr, *in litt.*).

REMARKS

Our reasons for placing *C. j. grandensis* in the synonymy of *C. amax* are given under the latter species.

***Carlia longipes* (Macleay)**
(Fig. 20,21,22)

1877 *Heteropus longipes* Macleay. *Proc. Linn. Soc. N.S.W.* 2: 66. Endeavour River, NE Queensland. Holotype AM R31878.

1877 *Heteropus variegatus* Macleay. *Ibid.* 2: 66. Darnley Island, N Queensland. Lectotype AM R31869 (Mitchell, 1953).

1877 *Heteropus sexdentatus* Macleay. *Ibid.* 2: 67. Cape Grenville, NE Queensland. Lectotype AM R31879 (here designated).

1877 *Heteropus quinquecarinatus* Macleay. *Ibid.* 2: 67. Darnley Island, N Queensland. Lectotype AM R31873 (here designated).

1877 *Heteropus cheverti* Macleay. *Ibid.* 2: 67. Barrow Island, NE Queensland. Lectotype AM R31877 (here designated).

1885 *Heteropus maculatus* de Vis. *Proc. Roy. Soc. Qd* 1: 169. Cape York, NE Queensland. Type material missing, see Covacevich (1971).

1885 *Heteropus rubricatus* de Vis. *Ibid.* 1: 170. Cape York, NE Queensland. Type material missing, see Covacevich (1971).

MATERIAL EXAMINED

WESTERN AUSTRALIA: 'West Australia' (MV D1384). NORTHERN TERRITORY: Milingimbi, Crocodile Island (MV D208-10); S of Nip Pt, Marchinbar Island, (NTM

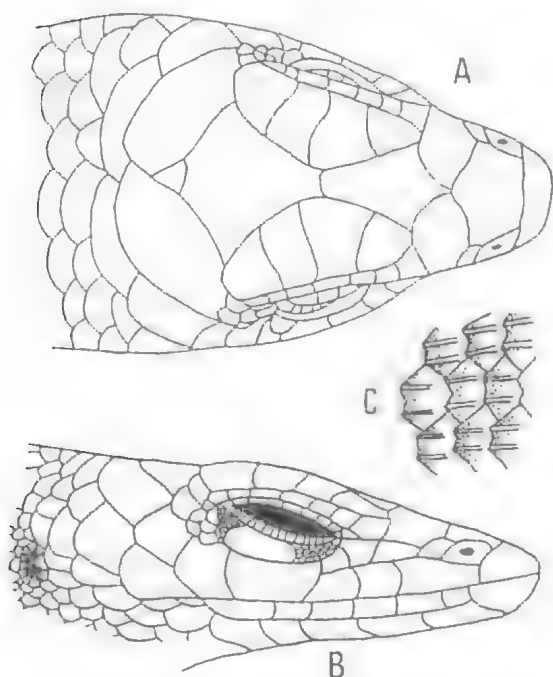


FIG. 19. *Carlia johnstonei* (QM J23977): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

R8950); Derby Creek, Arnhem Land (MV DT-D200, 202, 206-7, 776-8); Groote Eylandt (AM R25782-3; NTM R3357, 7350, 7566); Angurugu Mission, Groote Eylandt (AM R26282); Gove (NTM 1032, 6179); Yirrkala (AM R12093); Cape Arnhem (AM R246); Flat Rock Creek (NTM 5989); Giddy River crossing (R5990-1); no data (NTM R9452).

QUEENSLAND: Darnley Island (AM R31868-81, 42442, 42494; QM J1509); Yam Island (AM R42367); Gabba Island (AM R48476); Boigu Island (AM R48503-4, 48510); Saibai Island (AM R48212, 48214, 48233, 48240, 48314); Dauan Island (AM R48551-2, 48554); Yorke Island (AM R44318-24; QM J6438); Murray Island (AM R42491, 42578, 44215-8, 45902, 45916, 45968-9, 46107, 46121, 46123); Dowar Island (AM R45901, 45935-6, 45939); Mabuig Island (AM R48568-9); Coconut Island (AM R42468-9); Badu Island (AM R48602, 48605); Moa Island (AM R46951-3); Sue Island (AM R42327-32, 42358-61, 42435-40, 42499-503, 42505-11); Hammond Island (AM R42239, 42271, 42285-93, 42297-300); Thursday Island (AM R42376-7; MV D4330-1); Friday Island (AM R38664-6); Horn Island (QM J25650-2, 25666-7, 25685-9, 25798-9, 25807-14; SAM R13675); Prince of Wales Island (AM R46331, 46599-600; QM J6445-6); Lake Boronto (QM J24633-5, 24652, 24797, 25552-5, 25557-8, 25596-8, 25991-2); 1 km W of Naru Point (QM J25601); between Lake Boronto and Lake Witchura (QM J24663); Somerset (QM J24616-8); 9.6 km SW of Somerset (AM R38567-8); 19 km NE of Bamaga (AM R38569-70, 38578-81, 38595); Red Island Point (AM R38577); 1.6 km N of Bamaga (AM R38571-6); Bamaga (QM J25620); Shotgun Creek crossing (QM J26245, 26248-9, 26254-5); Heathlands (QM J26200-1, 26213-20, 26624); Cape Grenville (AM R31879-81); Dulhunty River crossing (QM J24686-7); 9.6 km N of Moreton P.O. (AM R38591-2); Wenlock River at Moreton (AM R38596); 3 km N of Evans Landing, Weipa (QM J25778-84); 24 km NE of Iron Range (AM R38582-9); 24 km E of Iron Range (AM R38597); Iron Range (QM J7795-9); 43 km NE of Pascoe River (AM R38598); West Claudie River on Iron Range Road (QM J24692-4); Claudie River (MV DT-D676, 680); Cape Direction (MV DT-D764-70, 772-4, 777); 1.6 km N of Pascoe River (AM R38600); Pascoe River crossing on Iron Range Road (QM J24673-5); Nichol River crossing, 21 km S of Pascoe River (QM J24667); Archer River (QM J7800-1); Lower Archer River (MV DT-D211-28, 775); 46 km N of Coen (AM R38590); 19 km N of Coen (AM R38594); Vardon Lagoon, Rokeby (QM J23434, 23439); turnoff to Iron Range and Weipa (AM J24645); Spear Lagoon, Rokeby (QM J23463); Clay Hole, Rokeby (QM J23480); Peach Creek (QM J23525); Rocky River (AM R16280-2, 16300, 16304, 16328); McIlwraith Range (QM J21394-5, 21397); 5 km up Lankelly Creek from Coen bridge (QM J26266-8); 4 km N of Coen (QM J23339); Coen (AM R16507, 16511-2, 16543-4, QM J7802); Coen (MV D10271; AM R38593; WAM R45608); 17 km E of Coen (QM J21396); King River (SAM R9881a,b); Bathurst Head (SAM R1942); Melville Range (QM 20508-9, 20511-12, 20596); mouth of the McIvor River (QM J20597, 20605-8); 17 km NW of

Cooktown (QM J17897); 9 km NW of Cooktown (QM J17829); Endeavour River (QM J11154-7; SAM R9743, 9748, 9749a,b, 9750, 9771, 9793; AM R31878); Barrow Island (AM R31876-7); Isabella Falls via Cooktown (QM J24518-9); 14 km W, 3 km N of Cooktown (SAM R9763a,b); Cooktown (QM J24396, 24531); mouth of the Annan River (MV D13915); Mt Hartley (QM J25133); Granites, Home Rule (QM J25163); Wallaby Creek, Home Rule (QM J25180); Home Rule Falls (QM J25292); Home Rule (SAM R9754); Shiptons Flat (QM J11152, 17822-3, 17825, 17827, 17832-4, 17884, 17898-9, 17900, 17905); McLeod River via Mt Carbine (QM J11163-4); 24 km N of Cairns (QM J24193-5); Kuranda Range State Forest, 3 km along Black Mt Road (QM J26692); Cairns (QM J14505); 15 km from Gordonvale on Gillies Highway (QM J25556).

DIAGNOSIS

A very large (maximum SV 65) *Carlia* with smooth or weakly tricarinate mid-dorsal scales with smoothly curved posterior edges; ear aperture vertically elongate, with long pointed lobules on anterior edge and smaller ones on other margins. Distinguished from *C. rhomboidalis* and *C. rubrigularis* by a free interparietal. For differences from *C. rostralis* see the diagnosis of that species.

GEOGRAPHICAL VARIATION

Northern Territory specimens have a weakly developed pattern that is similar to that of Queensland specimens, which are more intensely patterned and coloured. The ground colour is golden brown; the prefrontals are closer together, sometimes touching, and the first loreal is more elongate. In the Torres Strait, populations vary from island to island but show a general trend of intergradation between SW Papua New Guinea and Cape York. This trend is not smoothly clinal. Some insular forms have combinations of small differences in colour, pattern, meristics and external morphology that allow them to be allotted to the island or island group where they were collected. The western island populations are closer to Cape York *longipes* in colouration but differ in having long pointed lobules on the margins of the ear aperture. The populations of the islands close to Papua New Guinea are similar to specimens from there. The central and eastern islands are more similar in colouration and pattern to southwestern Papua New Guinean specimens than they are to those from Cape York Peninsula. Murray and Darnley Island specimens have distinctive juvenile and adult patterns. Southwestern Papuan specimens have similar juvenile patterns to Australian mainland specimens. The pattern of the preserved adults examined is not well defined



FIG. 20. *Carlia longipes*, tip of Cape York Peninsula (Steve Wilson).

and colours have faded with preservation. Some appear to have had red lateral surfaces.

DISTRIBUTION

Southern New Guinea, NE Northern Territory and NE Queensland. In the Northern Territory, NE Arnhem Land, Crocodile Island, Marchinbar Island and Groote Eylandt. In Queensland, Torres Strait Islands and Cape York Peninsula, south to Weipa in the west and Gordonvale area in the east.

DESCRIPTION

SV: 33-65 (N = 301, mean 49.3). HW: 13-17 (N = 231, mean 15.5). TL: 150-205 (N = 107, mean 179.9).

Prefrontals separate, very rarely in contact. Supraciliaries 7, occasionally 6 or 8 (N = 581, mean 7.0). Palpebral disc small, occupying about half of lower eyelid. Ear aperture about same size as disc, usually with one to many long pointed lobules on anterior margin and several smaller pointed lobules round other margins. Midbody scale rows 30-41 (N = 256, mean 33.8); mid-dorsal scales smooth to weakly tricarinate, with smoothly

curved, posterior edges. Lamellae under fourth toe 25-37 (N = 240, mean 31.5).

Colour and pattern varies between the two stages described below. Juvenile: dorsally brown with well defined dorsolateral lines from behind eye continuing for varying distances down back; sides black with a wavy midlateral line from under eye through ear continuing for varying distances along side; white spotting above and below this line, also large blotches and vertical dashes in front of forelimb. Adult males and females: dorsally brown; indistinct white dorsolateral line from behind eye to just past forelimb; black stripe from nostril through eye, above ear and terminating just behind forelimbs; sides red; legs and tail orange brown; labials and lower lateral surface in front of forelimb bluish white. Adults apparently lose the red colouring during the dry season. Ventrally white.

HABITAT

Ground cover in all vegetated habitats except rainforest; also monsoon forest in dry seasons.

REMARKS

Carlia longipes is a member of the *C. fusca* complex. Species of this complex occur in western Indonesia, New Guinea, New Britain, the Marianas and northern Australia. Specimens exhibit great variation in colour and pattern, while varying little morphologically or meristically. We have examined the holotype of *Heteropus fuscus* Duméril and Bibron, 1839, which was the name to which Mitchell (1953) referred *longipes*. The holotype (MNHP 3036 from 'Waigiou and Rawack' Islands, Irian Jaya) is not in good condition. There is little to be said about the specimen other than that it is a member of the *C. fusca* complex. We have avoided revising all the forms of this group in New Guinea because of the lack of ecological and colour data and because there is a need to collect specimens in critical areas (e.g. Irian Jaya) before a final placement of the many available names can be made. The *Carlia fusca* complex is not comprised of distinct forms that are largely allopatric as Loveridge (1948) thought, because in some cases, distinct forms are sympatric but largely restricted to one habitat type

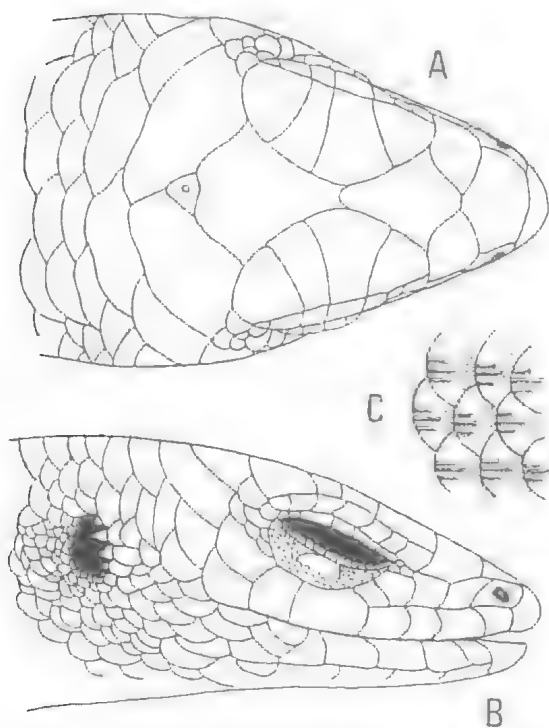


FIG. 21. *Carlia longipes* (QM J24694): A, Dorsal view of head, B, Lateral view of head. C, Mid-dorsal body scales.

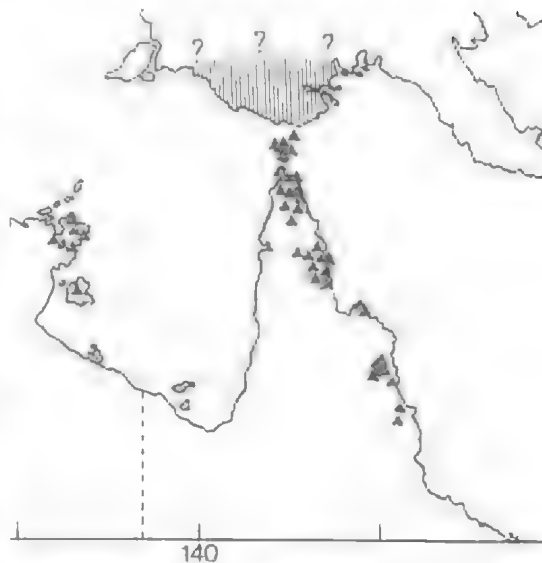


FIG. 22. Distribution of *Carlia longipes* (▲).

(F. Parker, pers. comm.). From a preliminary examination of Papua New Guinea specimens, *C. longipes* appears to be restricted to the southwestern Province. The Australian and the similar form in southwestern Papua New Guinea are distinct from related forms in New Guinea and *longipes* Macleay has been chosen as the available name because of page priority. Mitchell (1953) divided Australian specimens into *Leiopisma fuscum* (Duméril and Bibron) for those from the mainland and *L. f. variegatum* (Macleay) for those from the Torres Strait, and used the presence or absence of dorsolateral markings to separate the two. Queensland specimens, however, have very well defined dorsolateral markings and this division can not be supported. Storr (1974) followed Mitchell in allotting the Northern Territory populations to the nominate subspecies. These have patterns and colours that appear to be 'washed out' versions of those exhibited by Queensland specimens, and adults are reminiscent of adult *longipes* in southwestern Papua New Guinea but are lighter in colouration.

We have examined the syntypes of *Heteropus quinquecarinatus* Macleay (AM R31871-5), *Heteropus sexdentatus* Macleay (AM R31879-81) and *H. cheverti* Macleay (AM R31876-7) and have selected as lectotypes R31873, R31879 and R31877 respectively.

Keast (1962) lists *Leiopisma fuscum* from northern Western Australia, but Kluge (1963) doubted that this species occurred there. There is a specimen in the Museum of Victoria (D1384)

labelled 'West Australia' but it has a typical pattern exhibited by Queensland specimens of *C. longipes* and there is little doubt that the locality is inaccurate.

***Carlia munda* (de Vis)**
(Figs 23,24,25)

1845 *Mococa melanopogon* Gray. 'Catalogue of the specimens of lizards in the collection of the British Museum', p. 81. Port Essington, NT. Holotype BMNH 1946.8.16.42. (Name rejected by Boulenger, 1887, as secondary homonym of *Lygosoma melanopogon* Duméril and Bibron).

1885 *Heteropus mundus* de Vis. *Proc. Roy. Soc. Qd* 1: 172. Syntypes missing, from Warro, Port Curtis, Queensland. Neotype here designated, QM J15654, from State Forest, foothills of Mt Larcom, Queensland.

MATERIAL EXAMINED

WESTERN AUSTRALIA: Shathole Canyon, Exmouth (WAM R51023, 52903-5); Bullara (WAM R51024); Marandoo Townsite, Mt Bruce (WAM R52712, 52726, 52736); Prince Regent River National Park (WAM R46903, 46949); Drysdale River National Park (WAM R50686, 50364, 50556).

NORTHERN TERRITORY: Garden Point, Melville Island (NTM 1175); Melville Island (NTM 1176); Snake Bay, Melville Island (NTM 2976); near Empire Springs, Reynolds River area (AM R52098); Darwin (AM R20219); Berry Springs Reserve (NTM 2833); 2 km S of Berry Springs (NTM 1965); Howard Springs (NTM 2092); Mt Carr (AM R52099-100; NTM 1235, 1243, 1246, 1966); Adelaide River Township (AM R52097); 1

km SW of Ban Ban Springs (NTM 3162); Pine Creek (NTM 3098-9, 3115, 3391); 10 km SE of Katherine (NTM 2608-12, 2619-26); Oenpelli (NTM 600-1); 1.6 km S of Tennant Creek (AM R52096).

QUEENSLAND: Near Cape Direction (MV DT-D183); Iron Range turnoff, c. 70 km S of Dulhunty River (QM J24666); 46.6 km N of Coen (AM R38498); Lower Archer River (MV DT-D184-199); Coen airfield (AM R16168, 16173); Coen (AM R16513, 16727-8); Wakooka Outstation, Cape Melville (QM J20483-4); 3 km from Wakooka on W Cape Melville Road (QM J20762-3, 20766, 20768); Strathgordon Station (QM J23930; SAM R9784a,b, 9873); King River (SAM R9848); Edward River Station (SAM R9792, 9944); Hann River, Kennedy road (MV D13177-9); Hann River (SAM R9806a,b, 9894); Kowanyama (AM R1704); 11 km N of Laura (AM R16312-4, 16475); Strathaven Homestead (SAM R9867, 9898a,b); Cook Highway, 32 km W of Mt Carbine (SAM R9766); Mornington Island (SAM R5356, 5380a,c,e, 5384a,c); Karumba (AM R27448); 'Gregory River' (QM J7774); 'Gregory and Norman River' (QM J23913-7); Mt Molloy (AM R3557); Campbell Creek, 3.2 km N of Johnstone River on main road (QM J21391); Lappa Junction (AM R16480, 16487); Black Rock, The Lynd (QM J23910-1); 66.3 km NW of Townsville (QM J26555); 30.7 km S of Townsville (QM J26562); 23.2 km E of Woodstock (QM J26576-7); Reid River, 60 km S of Townsville (QM J26572-7); Reid River, 60 km S of Townsville (QM J26572-5); Box Creek near Mt Dryandra (AM R47871-2); N of Proserpine (QM J25156-7); 3.2 km S of Marlborough (QM J24939); Rockhampton (MV D2213); Hobbie Gully landing, W Curtis Island (QM J24221); Curtis Island (QM J24226-8); State Forest, Mt Larcom (QM J15654); Mt Larcom (QM J24942-3); 25 mls from Gayndah (QM J11846); Upper Burnett River (AM R5497); 12.8 km W of Biggenden (QM J11845);



FIG. 23. *Carlia munda*, Mt Crosby, SEQ (Steve Wilson).

40) 2 km from Gayndah (QM J11846, 11849); Chinchilla (QM J24098); Forest Hill (QM J24835); Ipswich (QM J23912); 2.5 km W of Rosewood (QM J24828-30, 24847); Mt Crosby (QM J 44266).

DIAGNOSIS

A very small (maximum SV 44) *Carlia* with smooth, tristriato, or very weakly tricarinate mid-dorsal scales with smoothly curved posterior edges; large palpebral disc; ear aperture horizontally elongate; and a white line from below eye to top of ear, beginning again from bottom of the ear and continuing for varying distances along lateral surface. Further distinguished from *C. pectoralis* by its smoother scales, horizontally elongate ear aperture, colouration and pattern; and from *C. jarnoldae* and *C. rufilatus* by its smoother scales, fewer supraciliaries (usually 5 vs usually 7), colouration, and pattern.

DISTRIBUTION

Northern half of West Australia south to Cape Range, Hamersley Range and Mundiwindi; also Sir Graham Moore Island, Northern Territory south to latitude 21°S, also Melville and Bathurst Islands (Storr, 1974). Northwest Queensland including Mornington Island, Gulf of Carpen-

taria, Cape York Peninsula north to latitude 13°10', and eastern Queensland south to Ipswich and Chinchilla.

DESCRIPTION

SV: 19-44 (N = 99, mean 35.1). HW: 13-18 (N = 92, mean 16.0). TL: 132-200 (N = 31, mean 165).

Prefrontals usually separated, touching or forming a narrow suture in 17% of specimens. Supraciliaries 5, occasionally 6 (N = 211, mean 5.2). Palpebral disc large occupying much more than half of lower eyelid. Ear aperture much smaller than palpebral disc, horizontally elongate, usually with a few small lobules on upper edge and occasionally smaller ones on other margins. Midbody scale rows 24-32 (N = 96, mean 29.0); mid-dorsal scales smooth, tristriato or weakly tricarinate, usually with smoothly curved posterior edges. Lamellae under fourth toe 21-31 (N = 92, mean 26.2).

Colour and pattern varies between the two extremes described below. Dorsally and laterally olive, spotted with black and white. White line outlined in black, from under eye and inserting at top of ear, recommencing below ear and continuing for varying distances between fore- and hindlimb. In breeding male, midlateral line always reaches hindlimb; body dorsally and laterally speckled with black and white tending to form longitudinal lines; lateral surface suffused with red; side of head and neck dark, throat, neck, and chin scales heavily lined in black. Ventrally white.

For description of Western Australian and Northern Territory specimens, see Storr (1974: 155).

HABITAT

Grassy ground cover. Open forest, woodland, stony ridges, and agricultural lands. Mostly lowlands. Storr (*in litt.*) notes that *C. munda* 'is also a dry site/dry country species. It is probably more varied ecologically than *C. triacantha*. It is found in woodland savannas, on black-soil plains, in spinifex, and in the leaf litter of waterside vegetation.'

REMARKS

Storr (1974), Cogger and Lindner (1974), and Greer (1975) showed that the name *Mocosa melanopogon* Gray applied to this taxon. Cogger and Lindner, and Greer accepted *melanopogon* as the available name, but as Storr (1974) noted, this name is not available under article 59 of the *International Code of Zoological Nomenclature*. It was

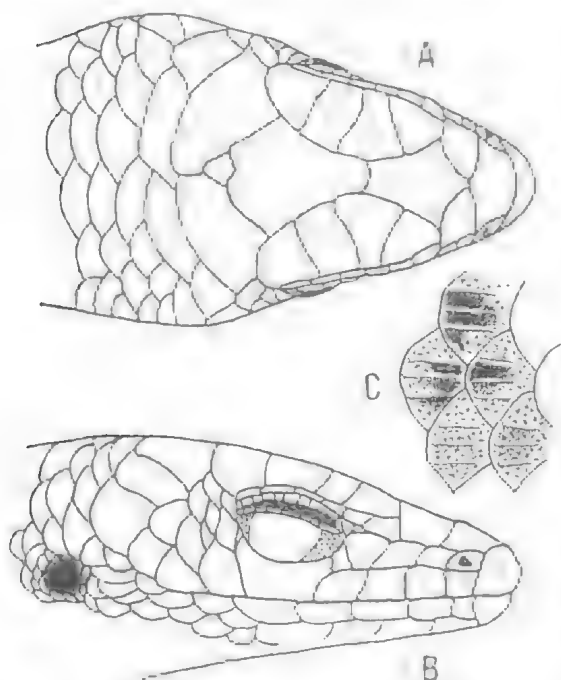


FIG. 24. *Carlia munda* (MV DT-D195): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

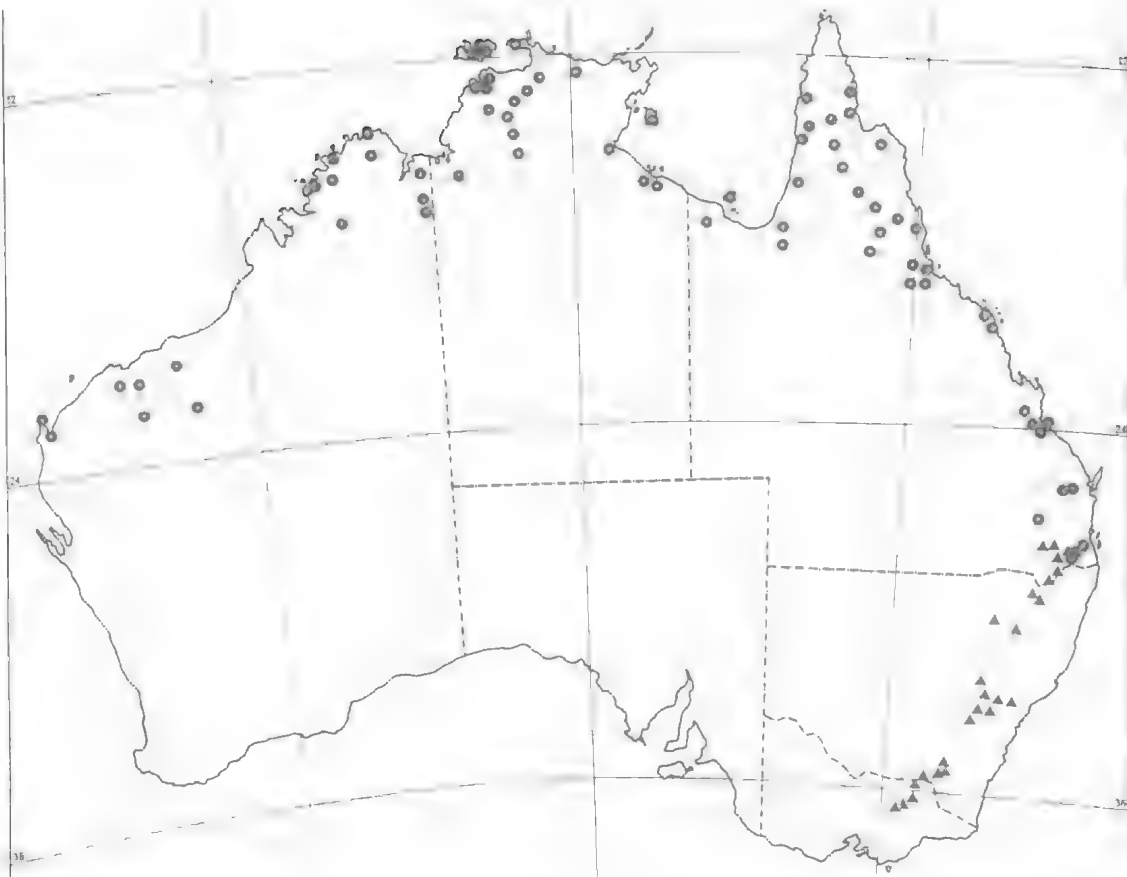


FIG. 25. Distribution of *Carlia munda* (●) and *C. tetradactyla* (▲).

rejected by Boulenger (1887: 288) as a junior secondary homonym of *Lygosoma melanopogon* Duméril and Bibron. Storr used *foliorum* as the available name. Ingram and Covacevich (1988), however, concluded that *Lygisaurus foliorum*, de Vis, 1884, was a senior synonym of *Ablepharus burnetti* Oudemans, 1894, and that *Heteropus mundus* de Vis, 1885, was the valid name.

Mitchell (1953) and Covacevich (1971) could not locate the syntypes of *Heteropus mundus* in the Queensland Museum, but de Vis's description of the ear aperture, dorsal scales and of the 'white line from the preorbital to upper hinder edge of ear orifice, recommencing below it' leaves little doubt that the name *mundus* applies to the same taxon as *Mocoo melanogapon*.

To stabilize the nomenclature we have selected a neotype for *Heteropus mundus* de Vis, 1885, from near the original locality of 'Warro'.

Neotype: QM J15654 State Forest, foothills of

Mt Larcom, Queensland (23°49', 151°02') collected by J. Covacevich and T. Tebble on 6 September, 1968.

SV: 33. HW: 17. Tail broken.

Prefrontals touch. Supraciliaries 5. Palpebral disc large occupying much more than half of lower eyelid. Ear aperture much smaller than palpebral disc, horizontally elongate, with small lobules around the margins. Midbody scale rows 30; mid-dorsal scales smooth and tristriated. Lamellae under fourth toe 26.

Olive dorsally and laterally, except for black blotches forming vertebral and paravertebral series. Also there are some white and black dots laterally along with a white line that commences in front and below the eye, continues backwards and inserts on top of the ear, recommences below the ear and continues backwards until it breaks up into dots in the midbody area.

***Carlia mundivensis* (Broom)**
(Figs 9, 26, 27)

1888 *Heteropus vertebralis* de Vis. *Proc. Linn. Soc. N.S.W.* 2: 821. Chinchilla, SE Queensland. Lectotype J248 (Mitchell, 1953). (Name rejected by Zietz, 1920: 211, as a junior secondary homonym of *Lygosoma vertebrale* Hallow).

1898 *Lygosoma mundivense* Broom. *Proc. Linn. Soc. N.S.W.* 22: 643. Muldiva, NE Queensland. Holotype BMNH 1946.8.17.81.

1920 *Lygosoma waitei* Zietz. *Rec. S. Aust. Mus.* 1: 211. (Replacement name for *Heteropus vertebralis* de Vis).

MATERIAL EXAMINED

QUEENSLAND: Cairns district (AM R54631); Mareeba (AM R26087, 26156); 7 km W of Chillagoe (QM J42080-2); Stannary Hills (QM J14015-21); Petford (AM R16473); 4 km E of Watsonville, via Herberton (QM J42128-9); Gorge Creek, Herberton to Petford road (QM J47101); Irvinebank (SAM R2967-8); Koban (SAM R2958); Millstream Falls (AM R47189); Moongobulla (QM J26635); Castle Hill (QM J4408); 'Spyglass' (QM J44686); 'Wando Vale' (QM J44432); 'Fletcher Vale' (QM J44422-3, 44425, 44858); 'Lochwall' (QM J44427-31); 'Toomba' (QM J44424, 44426, 44847-8); 'Glencoe' (QM J44580); 'Lolworth' (QM J 44565, 44570); Mt Cooper (QM J44317, 44716-7); Homevale (QM J33864, 33866, 33871-2, 33874, 33882, 33885, 33887, 33922-38, 33944-5, 33971); Mt Morgan (AM R47190); Marble Mountain (AM J25950); Chinchilla (QM J248, 13719-22).

DIAGNOSIS

A medium sized (maximum SV 56), mottled, dark *Carlia* with strongly tricarinate and/or bicarinate mid-dorsal scales which are hexagonally shaped or with curved posterior edges; midbody

scales rows 34-42, usually 36 or more; ear aperture round, with 9-16 acute lobules around margin.

DISTRIBUTION

Eastern Queensland, from the Chillagoe-Mareeba area, NE Queensland, south to Chinchilla, SE Queensland.

DESCRIPTION

SV: 28-56 (N = 49, mean 46.3). HW: 16-20 (N = 47, mean 18.0). TL: 130-173 (N = 15, mean 155).

Prefrontals usually separate (touching or forming a median suture, in 8% of specimens). Supraciliaries 7, occasionally 6 or 8 (N = 97, mean 7.1). Palpebral disc small. Ear aperture smaller than, or equal to palpebral disc, longer axis vertical, with a series of 9-16 short to long pointed lobules around margin. Midbody scales rows 34-42 (N = 46, mean 38.8). Mid-dorsal scales can be bicarinate and/or tricarinate, hexagonally shaped and/or with rounded posterior edges or a heterogeneous assemblage of these four characters. Lamellae under fourth toe 22-30 (N = 49, mean 24.0).

Head brown with darker mottling, short pale line from eye to temporals; pale subocular line; upper, lower labials and side of face blotched or barred. Dorsal and lateral surface of body, legs and tail heavily blotched with black and brown and with pale speckling; lighter areas tend to form ill-defined vertebral, dorsolateral, and mid-lateral lines which become distinct on tail, and ill-defined transverse barring. Ventrally bluish with some dark speckling under tail and along side of throat.



FIG. 26. *Carlia mundivensis*, Homevale via Nebo, MEQ (David Knowles).

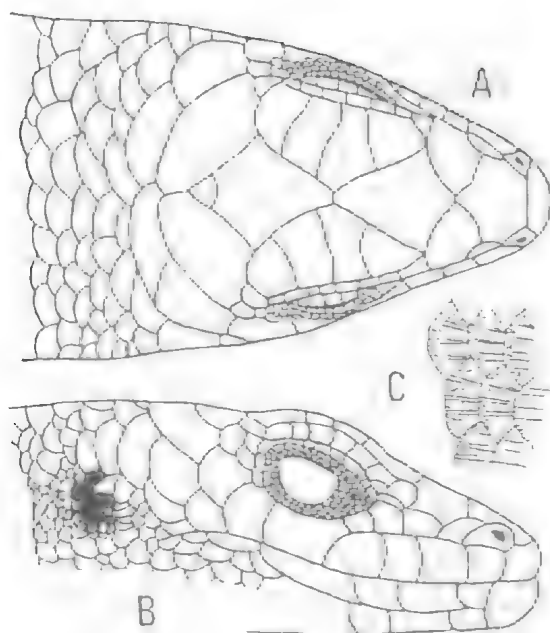


FIG. 27. *Carlia mundivensis* (QM J33922): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

HABITAT

On rocks, tree roots, and in hollow trees in open forest or dry vine forest along creeks in rocky areas. A large population of *C. mundivensis* was discovered during general rainforest surveys in a semi-evergreen vine thicket along a rocky creek on Homevale Station, via Nebo, ME Queensland (Covacevich, 1976). Here, the species was extremely common. Specimens were active, apparently feeding, between 8.30 and 11.00am.

REMARKS

Mitchell (1953) suggested that *Lygosoma mundivense* Broom was a synonym of *Heteropus vertebralis* de Vis. Examination of photographs of the dorsal scales and side of head of the holotype of *L. mundivense*, and consideration of morphological and meristic data provided by Mr A.F. Stimson of the British Museum, confirm Mitchell's opinion. Cogger (pers. comm.), who has examined the holotype of *mundivense* and the lectotype of *vertebralis*, concurs. Mitchell's use of *vertebralis* as the available name, however, was unfortunate. It is not an available name under Article 59 of the *International Code of Zoological Nomenclature* because it was rejected by Zietz (1920), as a junior secondary homonym of *Lygosoma vertebrale* Hallow.

Little is known about this lizard which has been collected in only five broad areas over its 1900km range. It is similar in many ways to two other rock-dwelling *Carlia* species, (*C. scirtetis* and *C. coensis*), but lacks the long legs and the 'broken' keels on the scales of those two species. These three species share the habit of running under and below boulders when disturbed and then coming up the other side to watch the disturbance.

Carlia pectoralis pectoralis (de Vis) (Figs 28,29,30)

1884 *Heteropus pectoralis* de Vis. *Brisbane Courier*, November 15, p. 6. [Queensland]. Holotype QM J1414.

1885 *Heteropus lateralis* de Vis. *Proc. Roy. Soc. Qd* 1: 168. Pine River, Moreton Bay District, SE Queensland. Lectotype QM J234, here designated. (Name rejected by Boulenger, 1890: 79 as a secondary homonym of *Lygosoma lateralis* Duméril and Bibron).

1885 *Heteropus pectoralis* de Vis. *Proc. Roy. Soc. Qd* 1: 169. Warro, Port Curtis, Queensland. Holotype QM J1414.

1890 *Lygosoma devisii* Boulenger. *Proc. Roy. Soc. Lond.* p. 79. (Replacement name for *Heteropus lateralis* de Vis).

MATERIAL EXAMINED

QUEENSLAND: Mt Molloy (QM J19417-8); St Ronans (AM R47142); Kirrama Range (AM R37487, 37490-1); Cardwell (QM J26602); Herbert Gorge (QM J2461-3, 2466-7); Magnetic Island (QM J4403, 21021-2, 21024, 24402-5, 24423); The Common, Townsville (AM R27476-8); Townsville (QM J23644; MV D32107); 30.3km SE of Townsville (QM J26641-2, 26645, 26654); Oonoonba (QM J13330); 36.3km SE of Townsville (QM J26643-4, 26646-51, 26653, 26655-60); 18.3km W of Ayr (QM J26604); 30.7km S of Townsville (QM J26587); 41km S of Townsville (QM J25369); Reid River (QM J26571); Arthur Point, Shoalwater Bay (QM J17911); Mt Etna (QM J25746-7, 25759-61); 'Gaylong', Capella (QM J15734, 15785); Port Curtis (QM J1414); north end of Curtis Island (QM J24255-7); Rundle Range (QM J33759, 33795, 33806, 33816, 33830, 33845); State Forest, 60km E of Mt Larcom (QM J15650-3); Gladstone district (AM R24682); 11.2km S of Miriam Vale (QM J11732-4); Warro State Forest (QM J23797-803, 23836-8, 23840-1); Mt Warro (QM J23860-3); 9.6km S of Lowmead (QM J23865-6); Comingleh State Forest via Monto (QM J15691); Bundaberg (QM J22324, 23993); Carnarvon Range (QM J10910); Carnarvon Gorge (QM J22372, 22375-6, 26042); Goodnight Scrub, Burnett River (QM J24950-2); Cordalba State Forest (QM J15746-9); Woodgate Forestry Reserve, 32km E of Childers (QM J15735); Toogoom via Torbanlea (QM J6287, 6321-5, 6327); Robinsons Gorge (QM J24119-24); Eidsvold (QM J2211); Upper Burnett River (AM R5495-6); Biggenden (QM J24072); Gayndah (QM J11842);



FIG. 28. *Carlia pectoralis pectoralis*, Magnetic Island, NEQ (Queensland Museum).

Murphys Lake Taroom (QM J11735); Arcadia Valley via Injune (QM J25903, 25905); 19.2km NW of Gympie (QM J15777); Cooloola (QM J22480, 22482, 22487); Lake Coolomera, Cooloola (QM J24185); Teewah Creek, Cooloola (QM J24188-90, WAM R45005-7); Windera, 8km N of Murgon (QM J24889); 12km E of Burumba Dam (QM J24343); Burumba Dam (QM J24344); Chinchilla (QM J25958); Redbank Creek, W of Esk (QM J24555); Pine River (QM J234); Moonie (QM J24186-7, 241 1-2); Texas Caves area (QM J24940).

DIAGNOSIS

A medium sized (maximum SV 52) *Carlia* with mid-dorsal scales hexagonally shaped and mostly tricarinate; ear aperture vertically elongate with one or two enlarged anterior lobules. Further distinguished from *C. rufilatus*, *C. triacantha*, and *C. schmeltzii* by fewer supraciliaries (usually 5 vs 6 or 7) colour, and pattern. For differences from *C. gracilis*, *C. vivax*, *C. dogare* and *C. jarnoldae* see diagnoses of these species. Further distinguished from *C. p. inconnexa* in having predominantly tricarinate dorsal scales (vs predominantly bicarinate) and in lacking the series of black, longitudinal, dorsal stripes in breeding males.

DISTRIBUTION

Eastern Queensland from Mt Molloy south to the border and west to Capella, Carnarvon Range, Moonie, and Texas. Also Magnetic and Curtis Islands.

DESCRIPTION

SV: 20-51 (N = 141, mean 39.2). HW: 13-19 (N = 128, mean 16.0). TL: 115-254 (N = 58, mean 156.0).

Prefrontals separated, rarely forming a suture. Supraciliaries 5, occasionally 6, rarely 4 or 7 (N = 256, mean 5.2). Palpebral disc large. Ear aperture smaller than disc, longer axis vertical, usually with one or two enlarged lobules on anterior margin. Midbody scale rows 23-34 (N = 146, mean 30.4); mid-dorsal scales hexagonally shaped, usually tricarinate. Lamellae under fourth toe 19-31 (N = 145, mean 26.2).

Colour and pattern varies between the two extremes described below. In juveniles and females, brown-grey, often flecked with black and white, with a well defined white mid-lateral stripe from under eye through ear and continuing for

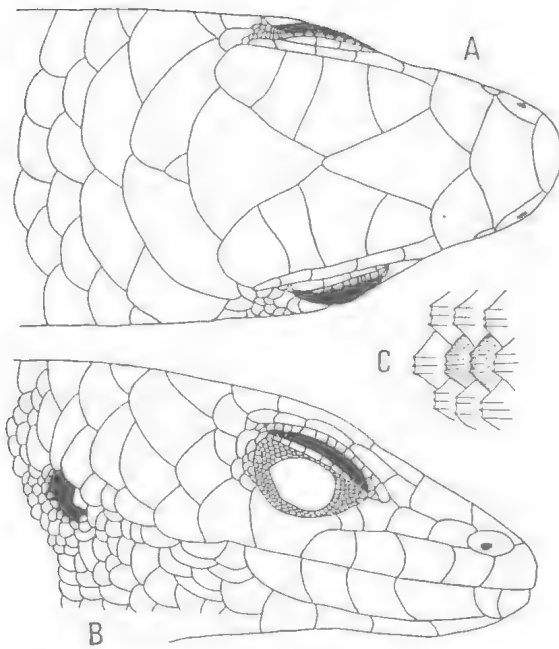


FIG. 29. *Carlia pectoralis pectoralis* (QM J24257): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

varying distances between ear and hind limb, often with a paravertebral series of darker ocellations, and sometimes with labials edged in black. In breeding males, red upper and lower lateral stripes between fore and hind limb, lower one can be broken up into spots; forelimbs and chest red, throat blue; labials, chin, and throat heavily lined in black.

HABITAT

Grassy areas in open forest, woodland, and agricultural lands.

REMARKS

An abstract (de Vis, 1884a) in a local newspaper pre-empted the formal description (de Vis, 1885) of *Heteropus pectoralis*. It said, 'Many of these lizards were gaily coloured, especially one (*H. pectoralis*), which had an orange chest bounded by red on either side, with a pale blue throat, mottled with dark brown'.

The holotype (QM J1414) of *C. p. pectoralis* does not match the measurements given in de Vis's formal type description. These measurements are, however, obviously inaccurate because the type would have a ridiculously long neck of about the same length as the distance between the fore and

hind limbs if these measurements are correct. The length of trunk given as 5.2mm may be a misprint for 3.2mm which is close to that of J1414. This specimen is as described in the remainder of the type description and there seems to be little reason to doubt that it is the single specimen described by de Vis. As well, although faded, the pattern of the specimen matches that described in de Vis (1884a).

The status of *lateralis* has been a matter of contention. It has been recognized as a 'good' species and also treated as a synonym of *peronii*, *vivax*, and *pectoralis* (Boulenger, 1887; Zietz, 1920; Loveridge, 1934; Mittleman, 1952; Mitchell, 1953). All decisions regarding the status of *lateralis*, with the exception of Mitchell's relegation of it to the synonymy of *pectoralis*, have been based only on the original description. Mitchell made his decision following examination of a specimen he regarded as the holotype of *lateralis*, (QM J234) and of the holotype of *pectoralis* (J1414). The former (J234) is a typical *C. p. pectoralis* in all respects. It is not, however, the holotype of *lateralis*. De Vis based his description of *lateralis* on more than one specimen ('... average adult length ...') and did not designate holotypes in any of his descriptions. Additionally, as Greer (1975) has noted, the alleged holotype of *lateralis* (J234) does not agree well meristically or morphologically with de Vis's type description. Despite the fact that J234 is not the holotype of *lateralis*, it is impossible to disregard the distinct possibility that J234 is one of de Vis's syntypes. The specimen was first registered in the Queensland Museum in 1912, some 27 years after *lateralis* was described. The original register entry describes the specimen as a 'type'.

The problem is further complicated by de Vis's work. His type description of *H. lateralis* fits that of a breeding male *C. vivax*. However, his probable syntype of *H. lateralis* (J234) agrees in all respects with *C. p. pectoralis*. The description of *lateralis* is brief but includes two features typical of *vivax* rather than *p. pectoralis* — 'Scales of the back and tail strongly bicarinate ...' (vs tricarinate); ... 'On the upper edge of the flanks between the limbs a bright copper-red stripe' ... (vs always two stripes even if one is broken or indistinct). Subsequent to this description, however, de Vis (1888, p. 822) used 'dorsals tricarinate' as a character of *lateralis* in a key to the *Heteropus* (= *Carlia*) of Queensland. In the same key *pectoralis* is separated from *lateralis* only on a number of midbody scale rows (32 vs 28). Oddly, the type description of *lateralis* gives 30 as the midbody scale count while J234 (the probable syntype

of *lateralis*) has 28 midbody scales, and thus agrees with his second reference to *lateralis* (1888) but not with his type description (1885). This situation is not inconsistent with de Vis's practice of basing type descriptions on several specimens but giving measurements and scale counts of only one syntype. The difficulty of deciding whether a particular specimen is or is not a de Vis 'type' has been discussed elsewhere (Covacevich, 1971).

In an effort to remove the confusion created by de Vis, and because J234 is probably the last remaining syntype of *Heteropus lateralis* despite some discrepancies, we have chosen this specimen as the lectotype of *H. lateralis*. *H. lateralis* thus becomes a junior subjective synonym of *C. pectoralis* (de Vis), confirming Mitchell's (1953) decision.

***Carlia pectoralis inconnexa* subsp. nov.**
(Fig. 30)

HOLOTYPE: AM R47178, Hayman Island, ME Queensland (20°03'S, 148°53'E), collected by F.A. McNeill.

PARATYPES: Hayman Island (AM R10823, 10826, 11015, 11522, 11719, 47165, 47177; QM J25060); Whitsunday Island (QM J42496); Lindeman Island (AM R9756, 10824);

DIAGNOSIS

See *C. p. pectoralis*.

DISTRIBUTION

Only known from Hayman, Whitsunday, and Lindeman Islands in the Whitsunday Group, MEQ.

DESCRIPTION

SV: 40-51 (N = 10, mean 46.2). HW: 15-18 (N = 10, mean 16.6). TL: 187-254 (N = 3, mean 217).

Prefrontals separated. Supraciliaries 5, occasionally 6, rarely 7 (N = 20, mean 5.2). Palpebral disc large. Ear aperture smaller than disc, longer axis vertical, usually with one or two enlarged lobules on anterior margin. Midbody scale rows 30-36 (N = 10, mean 33.1); mid-dorsal scales hexagonally shaped, usually bicarinate but commonly tricarinate; the bicarinate state appears to be derived from the tricarinate condition because the two keels are widely spaced as if the middle keel has been lost. Lamellae under fourth toe 26-32 (N = 9, mean 28.7).

Colour and pattern varies between the two extremes described below. Female with strongly black-blotched paravertebral and upper and lower lateral stripes on brown-grey background; the stripes are flecked with white; faint pale dorsolateral and midlateral lines; top of head brown with a few black blotches. Breeding male, top and sides of head and throat black; body and tail brown to bluish brown with up to ten black, dorsal stripes. Live breeding colours are unknown.

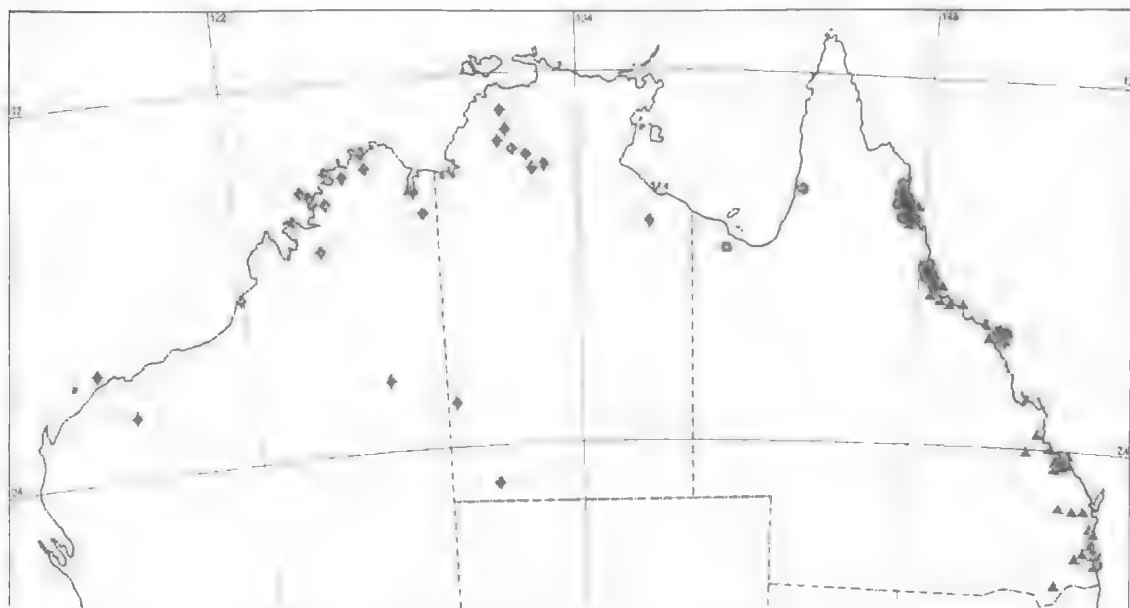


FIG. 30. Distribution of *Carlia pectoralis pectoralis* (▲), *C. p. inconnexa* subsp. nov. (★), *C. rostralis* (●), and *C. triacantha* (◆).

REMARKS

C. p. inconnexa appears to be a robust, melanistic, insular form of mainland *C. p. pectoralis*. However, field work needs to be done on the specific-mate recognition systems of the two forms to discover whether or not the gross differences in pattern do reflect specific status.

C. p. inconnexa and *C. vivax* illustrate some of the difficulties encountered in identifying similar taxa in the genus *Carlia* using only external features. In preservative, where colour and pattern are not very useful, if a specimen of the former has bicarinations or a specimen of the latter has tricarinations, it can be very difficult, if not impossible, to separate the two species. However, besides colour and pattern differences, *C. p. inconnexa* is a much more robust skink.

HABITAT

Unknown.

ETYMOLOGY

The name is from the latin that means 'unjoined', which is an allusion to the skinks insular environment.

***Carlia rhomboidalis* (Peters)
(Figs. 3,31,32)**

1869 *Heteropus rhomboidalis* Peters. *Mber. K. preuss. Akad. Wiss.* p.446. Port Mackay, Queensland. Lectotype ZMB 6509a (here designated).

MATERIAL EXAMINED

QUEENSLAND: Magnetic Island (QM J24421-2, 24434, 25896); Brandy Creek near Proserpine (QM J32745-52, 32762-63, 32778, 32792); Port Mackay (BMNH 1946.8.16.57; ZMB 6509a-e); Finch Hatton (QM J33992-09, 34030, 34032, 34041, 34043-5, 34048, 34059-60, 34063-4, 34068, 34070-3, 34080, 34085); Homevale (QM J33861, 33867, 33869, 33873, 33877, 33880, 33889, 33903-10, 33912-21, 33970).

DIAGNOSIS

A medium sized (maximum SV 57) *Carlia* with smooth mid-dorsal scales with smoothly curved posterior edges. Distinguished from all other *Carlia* species in having the interparietal fused with the frontoparietal scale. Distinguished from *C. rubrigularis* by throat and neck colour (blue and pink vs pink).

DISTRIBUTION

Northeastern to mid-eastern Queensland, from Magnetic Island in the north, south to the Clarke Range, near Mackay.

DESCRIPTION

SV: 21-57 (N = 58, mean 41.3). HW: 14-18 (N = 52, mean 16.2). TL: 125-174 (N = 23, mean 151.9).

Prefrontals separate, interparietal fused to frontoparietal, very rarely free. Supraciliaries 7, occasionally 6 or 8 (N = 119, mean 7.0) Palpebral disc small, occupying about half of lower eyelid. Ear aperture round, usually with one or two large

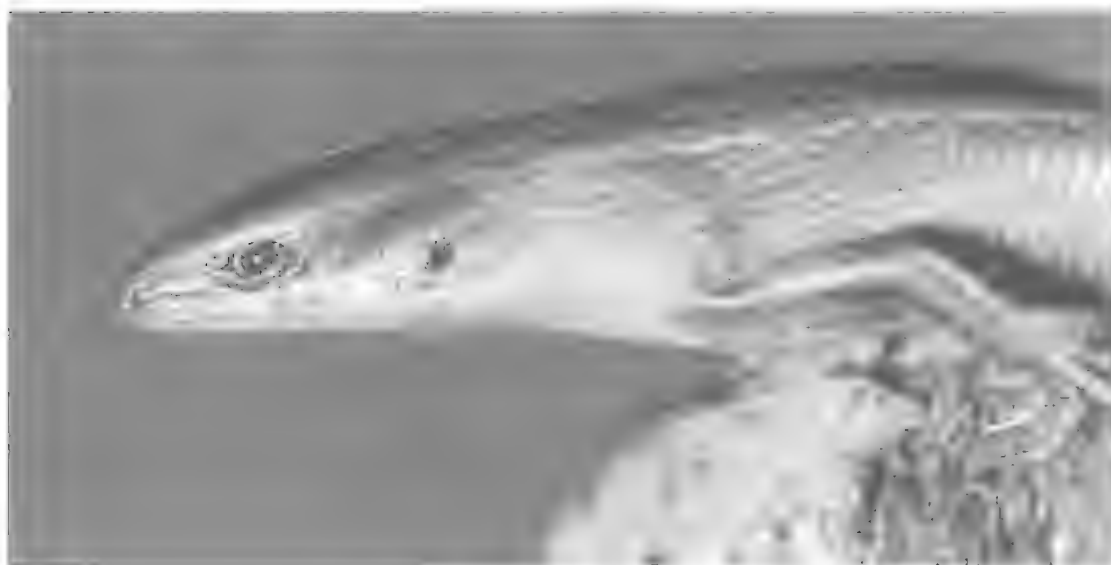


FIG. 31. *Carlia rhomboidalis*, Magnetic Island, NEQ (Queensland Museum).

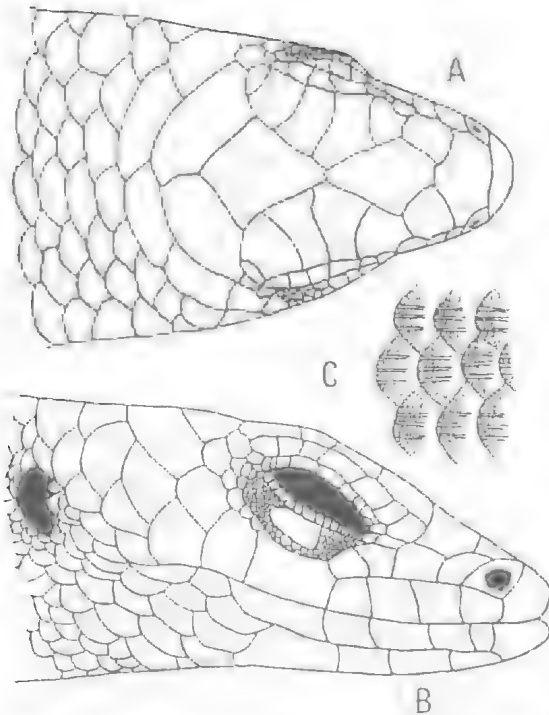


FIG. 32. *Carlia rhomboidalis* (QM J34032): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

pointed lobules on anterior margin and smaller pointed ones around edge. Midbody scale rows 29-36 ($N = 49$, mean 32.1); mid-dorsal scales smooth with smoothly curved posterior edges. Lamellae under fourth toe 25-31 ($N = 48$, mean 27.7).

In juveniles, copper head; gold or white dorso-lateral stripe from behind eye continuing indistinctly along tail; yellowish wavy line which may be broken up into dashes from under eye through eye midlaterally to hind limbs; dorsally brown with dark ocellations forming two paravertebral rows; laterally dark chocolate brown. In adult specimens, the dorsolateral and midlateral lines can be well defined but usually these are broken up or indistinct. In juveniles and adults, the throat, chin, and labials are blue, and neck and sides of neck are pink.

HABITAT

Rainforest and its margins.

REMARKS

The pink throated *C. rubrigularis* and the pink-blue throated *C. rhomboidalis* occupy distinct geographical ranges and may be allopatric subspe-

cies. Field work is required to see if these two forms overlap in the Townsville region and to see if the throat colours are important in the specific-mate recognition system. *Carlia* head-bob when conspecific individuals are sighted.

We have examined the syntypes of *Heteropus rhomboidalis* (BMNH 1946.8.16.57; ZMB 6509a-e) and have selected ZMB 6509a as the lectotype,

Carlia rimula Ingram and Covacevich (Figs 3, 33, 34)

1980 *Carlia rimula* Ingram and Covacevich. In Bailey, A. and Stevens, N.C. 'Contemporary Cape York Peninsula', p. 46. Second Claudie River Crossing, Iron Range Road, NE Queensland. Holotype QM J24602.

MATERIAL EXAMINED

QUEENSLAND: 0.7 km N of Pascoe River mouth (QM J31810); 0.5 km N of Pascoe River mouth (QM J32812); second Claudie River crossing, Coen-Iron Range road (QM J24602-7); Steene's Grave, 2 km E of Birthday Mountain (QM J37484); Buthen Buthen, Nesbitt River (QM J34476-7); Weather Station, 19 km ENE of Coen (QM J37422); Lankelly Creek, 8 km NE of Coen (QM J37423); Coen (AM R16527-8); 16 km E of Coen (AM R47138); 5 km along Lankelly Creek from Coen (QM J26280-3); 13 km S of Coen (QM J26299).

DIAGNOSIS

A very small (maximum SV 39) *Carlia* with smoothly curved posterior edges to the mid-dorsal scales; dorsal and lateral scales having 4 to 5 weak carinations with each keel broken up into a series of 2 to 5 smaller points. Further distinguished from *C. scirtetis* and *C. coensis* by its smaller size (maximum SV 39 vs 64, 68 respectively), low number of midbody scale rows (26-30 vs 40-45, 36-45 respectively); by colour pattern from *C. scirtetis*; and by the presence of an interparietal from juvenile *C. rhomboidalis* and *C. rubrigularis*.

DISTRIBUTION

From the mouth of the Pascoe River in the north and south to 13 km S of Coen, Cape York Peninsula, Queensland.

DESCRIPTION

SV: 23-39 ($N = 14$, mean 31.7). HW: 14-17 ($N = 13$, mean 6.0). TL: 131-175 ($N = 7$, mean 157).

Prefrontals separate; supraciliaries 7, rarely 8 ($N = 14$, mean 7.1). Palpebral disc large. Ear aperture usually smaller than palpebral disc, longer axis vertical with 9-11 sharp lobules around margin. Midbody scales rows 26-30 ($N = 13$, mean 28.0); mid-dorsal scales with smoothly curved

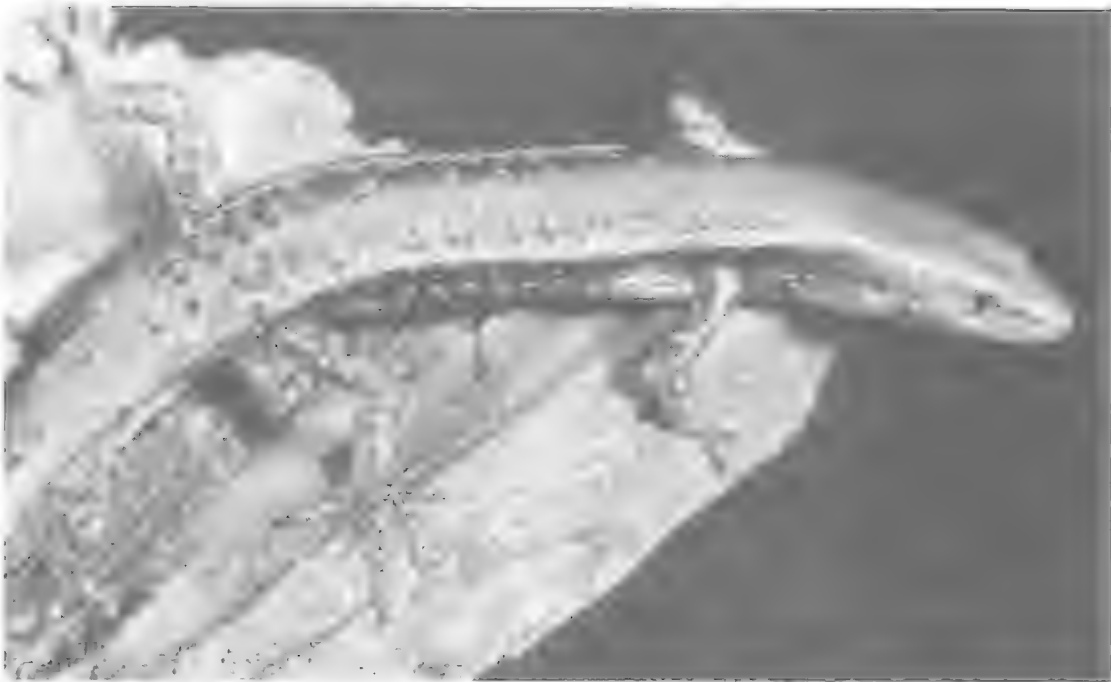


FIG. 33. *Carlia rimula*, 12.5km S of Coen, NEQ (Queensland Museum).

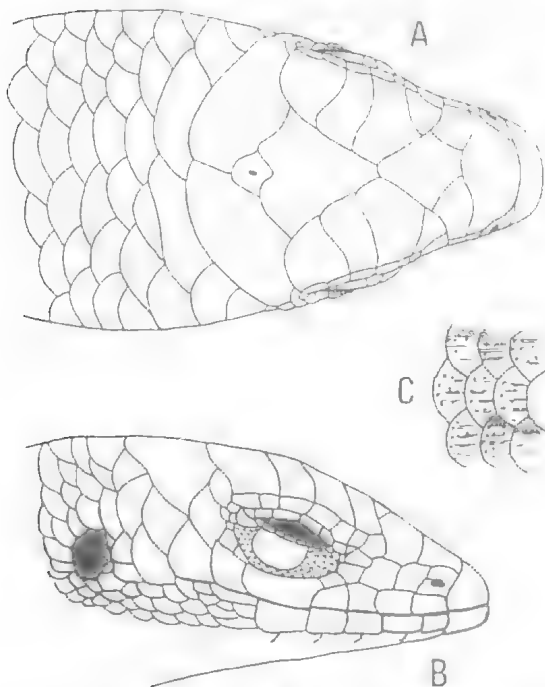


FIG. 34. *Carlia rimula* (QM J26280): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

posterior edges; dorsal and lateral scales have 4 to 5 weak carinations with each carination formed by a series of 2 to 5 smaller points. Lamellae under fourth toe 24-30 ($N = 13$, mean 27.4).

On upperparts, ground colour is brown-black, sometimes flecked with golden brown or white. Well defined gold-silver dorsolateral lines run from in front of and above the eyes to the tail. A similarly coloured midlateral line runs from behind the front legs to and along hindlimbs; and a distinct grey-brown vertebral line extends from the neck along the tail. Top of the head and neck are golden brown; sides of head and neck are lighter than the ground colour. Vertebral line may be poorly defined, but the dorsolateral line is always well defined and is sometimes indented with black-brown. In large males, the midlateral line may be absent or represented by golden flecking. Ventrally cream; feet black.

HABITAT

Rocks and associated leaf-litter in open vine-forest, usually along creeks.

REMARKS

Covacevich *et al.* (1982) concluded that *C. rimula* was a rare species.

***Carlia rostralis* (de Vis)**
(Figs 30,35,36)

1885 *Heteropus rostralis* de Vis. *Proc. Roy. Soc. Qd* 1:
171. Cardwell, NE Queensland. Holotype QM J230.

MATERIAL EXAMINED

QUEENSLAND: Gregory River (QM J231); Magnificent Creek, Kowanyama (QM J14130-6, 14138-50, 29295, 29372); Shiptons Flat (QM J22947); Collingwood, 5 km S of Home Rule (QM J24849); 12 km N of Palmer River on Cooktown Road (AM R92916, 97695-702); 10 km N of Palmer River (AM R56792); foothills, Mt Frazer (Q, J23456-8); 28.7 km NE of Cooktown Road via Windsor Tableland forestry road (AM R63917); Mt Molloy (WAM R 45609; AM R41345; QM J19338-9); Spear Creek, Mt Molloy (QM J27066); Crowley Creek, Mt Molloy (QM J27013); Bald Mt, near Mareeba (AM R26151); Davies Creek Road, 16 miles SE Mareeba (AM R53904); Black Mt Road, Kuranda (AM R47198-9); 3 km N of Kennedy Highway via Black Mt Road (AM R92915); Kuranda (AM R67086-90); Holloway Beach, via Casuarina Street (AM R97693-4); 9 miles N of Cairns (AM R66808); Tinaroo Dam (QM J11851); Herberton (AM R63846-7, 63858-62); Cardwell (QM J230); Hinchinbrook Island (QM J26112-3, 26120, 26340-1, 26367, 37941-2); Hencamp Creek, 5 km N of 1 km E of Rollingstone (QM J27695, 32570-5); 5-6 km NNE of Roll-

ingstone (AM R89743-55, 97687-9); 24.1 km ESE of Wallaman Falls National Park by road (AM R97690-2); Millstream National Park (AM R62276); 10 km W of Bruce Highway via Paluma Road (AM R97675-6); 1 km W of Moongobulla, 65.3 km NW of Townsville (QM J26618); 28.3 km WSW of Ross River Road in WSW Townsville via the Hervey Range Road (AM R97677-85); 29.1 km WSW of Ross River Road in WSW Townsville via Hervey Range Road (AM R89737-42, 97686); Hervey Range (QM J27618-9); no data (QM J2625, 2629-30).

DIAGNOSIS

A very large (maximum SV 70) *Carlia* with smooth or weakly tricarinated mid-dorsal scales with smoothly curved posterior edges; ear aperture vertically elongate, with large pointed lobules on anterior edge and sometimes smaller ones on other margins. Distinguished from *C. rhomboidalis* and *C. rubrigularis* by the presence of a free interparietal and from *C. longipes* by colour pattern (Males — boldly marked with black throat, black speckled back, black upper lateral stripe continuing to hindlimb and red lower lateral stripe vs comparatively drably marked with no black throat, with brown back, black upper lateral stripe continuing to forelimb, and red sides. Females — boldly marked with distinct white dorsolateral

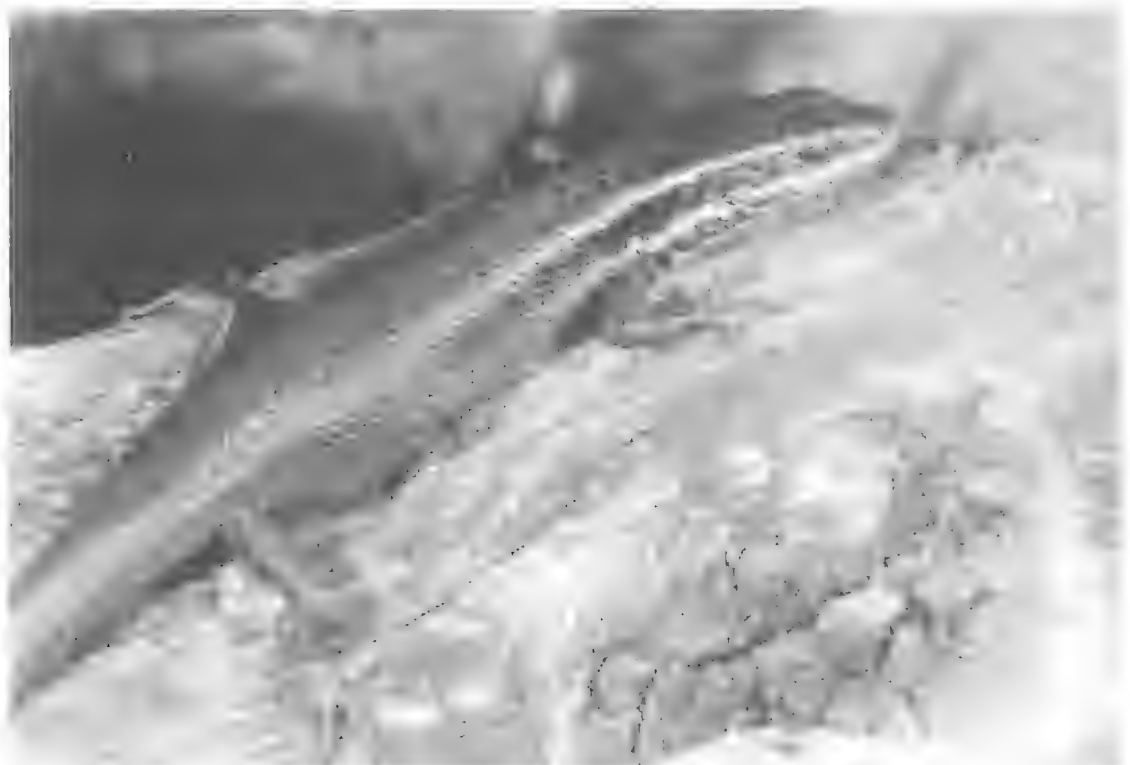


FIG. 35. *Carlia rostralis*, Hinchinbrook Island, NEQ (Queensland Museum).

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stripe and midlateral stripes continuing to behind forelimb vs same pattern as male *C. longipes*).

DISTRIBUTION

From Gregory River, NW Queensland, to NE Queensland from Kowanyama and Cooktown region in the north, south to the Townsville area.

DESCRIPTION

SV: 29-70 (N = 100, mean 49.6), HW: 14-19 (N = 69, mean 15.0). TL: 159-239 (N = 48, mean 184.7).

Prefrontals separate. Supraciliaries 7, rarely 6, 8, or 9 (N = 201, mean 7.1). Palpebral disc small, occupying about third of lower eyelid. Ear aperture usually larger than disc, and with large lobules on anterior margin and sometimes with smaller ones on other margins. Midbody scale rows 30-38 (N = 68, mean 34.1); mid-dorsal scales smooth to weakly tricarinated, with smoothly curved posterior edges. Lamellae under fourth toe 26-36 (N = 74, mean 30.8).

Colour and pattern varies between the two stages described below. In juveniles and females, dorsally brown with a few scattered black speckles and well defined dorsolateral lines from behind the eye continuing to behind the forelimb; lateral surface black from tip to snout to just behind forelimb with a well defined white midlateral line (this may be broken up into a series of dashes); labials flecked with black; posterior lateral half of body brown with or without a reddish tinge; white below. In males, brown above with intense black speckling or lines with a well defined white dorsolateral line from tip of snout, continuing for varying distances past forelimb; laterally a black stripe begins from nostril and terminates in front of hindlimb; lower lateral surface bright red in life (on neck this is often streaked with black); labials and chin yellow; ventrally white with black throat and neck.

HABITAT

C. rostralis is a ground-dweller in grasslands and woodlands but not in rainforests. However, it can be found in association with rocks and vine thickets.

REMARKS

C. rostralis encapsulates the difficult taxonomic problems in the *C. fusca* complex. Morphologically there is little difference between *C. longipes* and *C. rostralis*. In colour and pattern, they are very different. These differences probably play an important part in specific-mate recognition

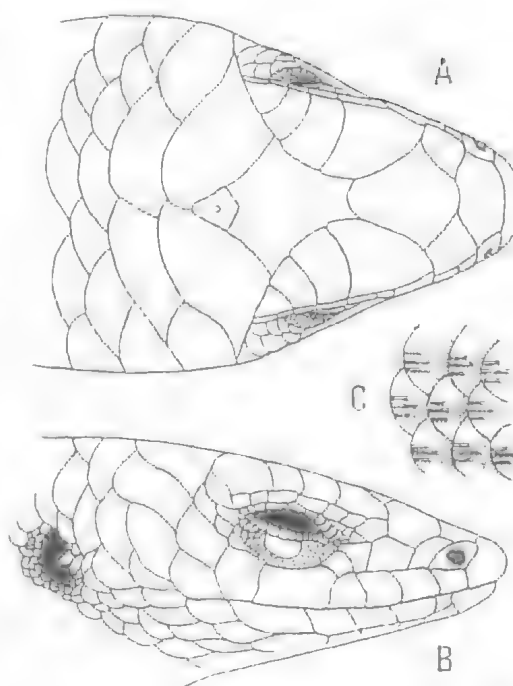


FIG. 36. *Carlia rostralis* (QM J14144): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

systems (e.g. during head bobbing and body posturing displays).

The holotype of *Heteropus rostralis* (QM J230) has faded and it is very difficult to see the pattern except under angled light. Even so, it is possible to identify it as a female of the taxon.

Wilhoft and Reiter (1965) probably studied the reproductive biology of this species. Unfortunately, they gave no details for their specimens.

Carlia rubrigularis sp. nov.

(Figs 3,37,38)

MATERIAL EXAMINED

HOLOTYPE: QM J29956, Innisfail, NE Queensland (17°32'S, 146°01'E), collected by D.C. Wilhoft on 18 April, 1960.

PARATYPES: Cooktown (AM R2271); Cooktown Lagoon (AM R41346); 27 km S of Cooktown (MV D13180); Big Tableland (SAM R9767); Home Rule (QM J25229, 25294, 25211); Home Rule, Slaty Creek (SAM R9757a-d); Home Rule Falls (QM J25141, 25212, 25293); Mt Hedley, Home Rule (QM J25240, 25242, 25245); Gap Creek, 12 mile Scrub (QM J25296-7); Mt Hartley (QM J25143, 25146, 25246-50, 25272); Shiptons Flat (QM J17826, 17901, 17906-7, 24649, 24800, 24807-8); Bloomfield River Scrub, c. 40 km S of Cooktown (QM J22668);



FIG. 37. *Carlia rubrigularis* sp. nov., Thornton Peak, NEQ (Steve Wilson).

Horan Creek, Mt Finnigan (QM J25209); track between Granite Creek and Cedar Bay (QM J25198-200).

OTHER SPECIMENS EXAMINED: QUEENSLAND: Marina Plains (QM J22945); Mossman Gorge (AM R20774-5); Mossman (AM R17118; MCZ 9132); Port Douglas (SAM R3893a,b); Mt Lewis (AM R28384-5); Rifle Creek, Mt Molloy (QM J25109); Mt Molloy (QM J 19416); Palmerston, Atherton Tablelands (AM R20204-6); Green Island (AM R36609); Kuranda (AM R21316); Cairns (AM R760-4); Tinaroo Dam (QM J11874); Tolga Scrub, Atherton (AM R41347-50); Russell Island (AM R36651-2, 36655-6, 36658-9); Lake Barrine (AM R16143; MCZ 35482-3); Atherton (AM R10834); Curtain Fig Tree, Yungaburra (AM R20200-3); The Crater, Mt Hypipameice (SAM R2981); Lake Eacham (QM J11875, SAM R2960-1, 2963-4); Mt Bartle Frere (AM R3980); Cucania (MCZ 35481); Crater, Atherton Tableland (QM J11873); Flying Fish Point (QM J14116-8, 14120-9, 22667, 25451; WAM R45614); Innisfail (QM J2492-9, 11876, 17433; SAM R2965, 2989); 17 km W of Innisfail (QM J17885-9). Johnstone River, Innisfail (QM J17890-1); South Johnstone River (AM R16333); Mt Garnet (AM R21321); Tully Falls (AM R16693-4); Sugar Cane Creek, Mission Beach (QM J24809); Tully (SAM R2952-62); Barrets Lagoon, 9.6 km E of Euramo (QM J17904); Kirrama Range, 12.8 km NW of Cardwell (AM R37492); Herbert River Gorge (QM J7785-7, 13867-8, 25062-5); 11.7 km S of Ingham (QM J26550-2); Paluma, Mt Spec (QM J26595-6).

DIAGNOSIS

A large (maximum SV 60) *Carlia* with smooth

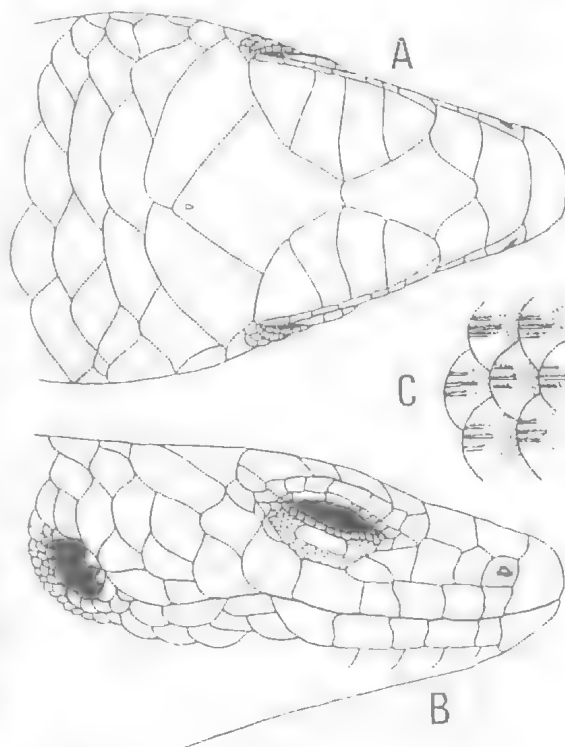


FIG. 38. *Carlia rubrigularis* sp. nov. (QM J24649): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

mid-dorsal scales with smoothly curved posterior edges. Distinguished from all other *Carlia* species in having the interparietal fused with the frontoparietal scale. Distinguished from *C. rhomboidalis* by throat and neck colour (pink vs blue and pink).

DISTRIBUTION

Rainforests of the Cooktown district, south to the Townsville area. Also Green, Russell, and Hinchinbrook Islands.

DESCRIPTION

SV: 22-60 (N = 135, mean 44.3). HW: 13-18 (N = 122, mean 17.0). TL: 117-182 (N = 40, mean 156.5).

Prefrontals separate, interparietal fused to frontoparietals, very rarely free. Supraciliaries 7, occasionally 6 or 8, rarely 9 (N = 142, mean 7.0). Palpebral disc small, occupying about half of lower eyelid. Ear aperture round, usually with one or two large pointed lobules on anterior margin and smaller pointed ones around edge. Midbody scale rows 28-37 (N = 123, mean 32.3); mid-dorsal scales smooth with smoothly curved posterior edges; scales with low tubercles in young. Lamellae under fourth toe 24-35 (N = 113, mean 29.2).

Colour and pattern as for *C. rhomboidalis* but juveniles and adults of *C. rubrigularis* have pink throats, necks, and lower sides of head.

HABITAT

Rainforest and its margins.

REMARKS

There is one specimen of *C. rubrigularis* in the

Queensland Museum collection from 'Marina Plains', 160km NW of Cooktown (J22945). We regard this as a doubtful record in the light of recent field work because the most northern known populations of *C. rubrigularis* occur in the Shiptons Flat-Home Rule rainforest, 30 km south of Cooktown, and there is no rainforest habitat 'suitable' for *C. rubrigularis* on Marina Plains, which is an area of salt pans and open grassland.

Wilhoft (1963a,b) has studied the reproductive biology of this species.

ETYMOLOGY

The name is from the latin that means 'red throat'.

Carlia rufilatus Storr (Figs 17,39,40)

1974 *Carlia rufilatus* Storr. *Rec. West. Aust. Mus.* 3: 157. Tumbling Water, Northern Territory. Holotype WAM R23271.

MATERIAL EXAMINED

WESTERN AUSTRALIA: 37km SE of Kununurra (QM J23973-4).

NORTHERN TERRITORY: Darwin (QM J2619-20, 7789; AM R20221); Port Darwin (QM J13687); Darwin airport (AM R52109, 52111); Mandorah, Darwin Harbour (AM R52108); Millner, Darwin (NTM 2433, 3302); 66 km S of Darwin (NTM 1812).

DIAGNOSIS

A very small (maximum SV 42) *Carlia* with hexagonally shaped and moderately tricarinate mid-dorsal scales and with longer axis of ear aperture horizontal. Distinguished from *C. gracilis* by



FIG. 39. *Carlia rufilatus*, Casuarina, NT (Steve Wilson).

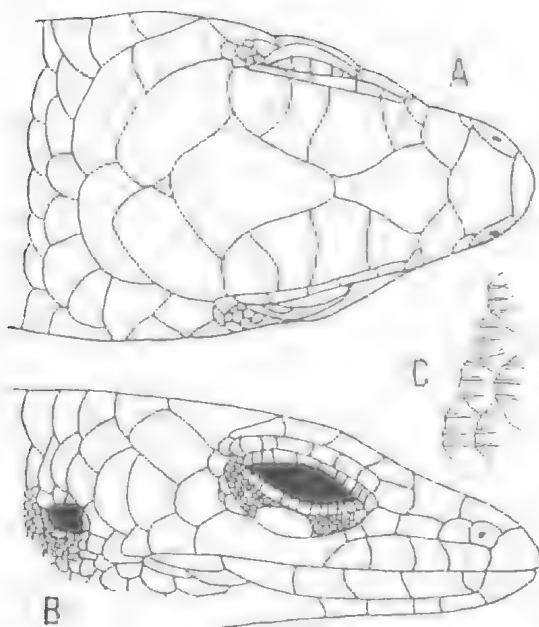


FIG. 40. *Carlia rufilatus* (QM J13687): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

larger palpebral disc (much more than half of eyelid vs about half of eyelid); from *C. munda* by stronger dorsal keels and angular, less rounded posterior edges of dorsal scales, from both *gracilis* and *C. munda* by more numerous supraciliaries (usually 7 or 6 vs usually 5); and from *C. jarnoldae* by coloration and pattern (juvenile and female — whitish stripe from under eye to ear and occasionally to foreleg vs distinct white line outlined in black from eye to hind leg; breeding male — red mid-lateral stripe vs 5 to 7 dark blue dorsal stripes, and with white flecked, thick dark blue upper lateral stripe with a red stripe below this).

DISTRIBUTION

Northwestern Northern Territory in vicinity of Darwin; far northern Western Australia in East and West Kimberley (Storr, 1974).

DESCRIPTION

See Storr (1974: 157).

HABITAT

'*C. rufilatus* is found in the leaf litter of moderately dense forests and woodlands (*Eucalyptus*, *Melaleuca*, *Pandanus*, *Acacia*, *Adansonia* etc.)' (Storr, *in litt*).

REMARKS

This species is similar to *C. jarnoldae*. The Northern Territory population of *C. rufilatus* closely resembles *C. jarnoldae* morphologically and meristically but pattern and colour differences are marked.

Carlia schmeltzii (Peters) (Figs 3,42,43)

1867 *Heteropus schmeltzii* Peters. *Mber. K. preuss. Akad. Wiss.* p.23. Rockhampton. Holotype ZMB 5750.

1975 *Carlia praya* Covacevich and Ingram, 1975. *Vic. Nat.* 92: 22. Magnificent Creek, Kowanyama, N Queensland. Holotype QM J14101.

MATERIAL EXAMINED

QUEENSLAND: Rocky River (AM R16678); 3km N of Coen (QM J26275-6); Coen (AM R16342, 16525); Magnificent Creek, Mitchell River Mission (QM J14094-5, 14097, 14099-103; WAM R45613); Cairns (AM R54629); 10km W of Mareeba (AM R47193); 8.4km W of Lappa Junction (AM R16448); Brownsville Battery near Mt Garnet (AM R21320); 66.3km NW of Townsville (AM J26556); 1km W of Moongobulla (QM J26619-20); Magnetic Island (QM J24397-401; 24959); 36.3km SE of Townsville (QM J26661); Reid River, 60km S of Townsville (QM J26570); 66km S of Townsville (QM J25369); 50.3km NE of Charters Towers (QM J26588-91); Bowen (QM J25365-6); Charters Towers (QM J24277, 24827; WAM R21487); Dent Island (AM R49834); Lindeman Island (AM R11163; QM J5639); Brampton Island (AM R13536, 47180-1); 4km N of Sarina (QM J24841); Homevale (QM J33886, 33894, 33942, 33967-8); Oakley Creek, Homevale (QM J33911); Nebo Creek via Nebo (QM J33951); South Percy Island, Northumberland Group (QM J778); 'Langham', Arthur Point, Shoalwater Bay (QM J7881); Byfield (QM J25740, 25744); Yeppoon (AM R15678-9; QM J21669-70); Mt Etna (AM J25750); Rockhampton (QM J7790; ZMB 5750); Rundle Range (QM J33779-80, 33783, 33786, 33791, 33793, 33803-5, 33807, 33817, 33820-1, 33824, 33826, 33841, 33844, 33851, 33856); Mt Warro (QM J23849-50); 1.6km W of Bundaberg (QM J22011); Bundaberg (QM J22320); Goodnight Scrub, Burnett River (QM J24948); Walla-ville (QM J24356, 24358-9); Cordalba State Forest (QM J15713); Robinsons Gorge (QM J24126, 24338, 24361); Eidsvold (AM R6006); Arcadia Valley via Injune (QM J25902); Twin Mountain, Beerwah (QM J27350); Somerset Dam (QM J11850); Stockyard (QM J26999); Mt French (QM J23994); Mt Barney (QM J21671); Barney View, Mt Barney (QM J21990-2); Queensland (MV D2045).

DIAGNOSIS

A very large (maximum SV 69) *Carlia* with hexagonally shaped, bicarinate and/or tricarinate mid-dorsal scales; ear aperture vertically elongate usually with two large squarish lobules on anterior



FIG. 41. *Carlia schmeltzii*, Magnetic Island, NEQ (Queensland Museum).

border. Further distinguish from *C. pectoralis*, *C. triacantha*, *C. vivax*, *C. dogare* by its smaller palpebral disc (about half of lower eyelid vs much more than half) and more numerous supraciliaries (usually 7 vs 5 or 6).

DISTRIBUTION

Cape York Peninsula, from Coen in the north and Kowanyama on the west coast, eastern Queensland, south to the Queensland-New South Wales border, west to Charters Towers and the Carnarvon Range. Also Magnetic, Lindeman, South Percy, and Brampton Islands.

DESCRIPTION

SV: 26-69 (N = 101, mean 51.4). HW: 14-19 (N = 95, mean 16.6). TL: 160-214 (N = 39, mean 188.0).

Prefrontals separated, rarely touching. Supraciliaries 7, occasionally 6, rarely 4, 5 or 8 (N = 185, mean 6.8). Palpebral disc small occupying about half of lower eyelid. Ear aperture about same size as disc, longer axis vertical, with usually two large squarish lobules on anterior margin. Midbody scale rows 31-38 (N = 82, mean 34.7), mid-dorsal scales hexagonally shaped, strongly bicarinate and/or tricarinate. Lamellae under fourth toe 23-30 (N = 92, mean 25.9).

In adults, head and dorsal surface brown, with or without black dotting, grey dorsolateral stripe

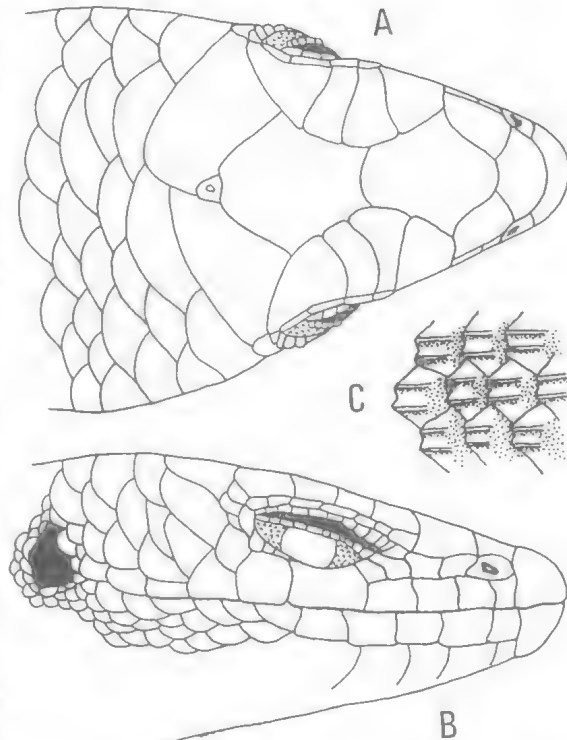


FIG. 42. *Carlia schmeltzii* (QM J14102): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

from above ear and along tail; lateral surface grey-brown, scales thickly edged in black; in front of forelimb, scales of upper lateral surface also edged in black, lower lateral surface grey, tail brown. In breeding males, sides red on lower surface, red flecked with black on upper surface, scales of labials and sides of neck and throat black-lined, with some black speckling on neck and throat. Juveniles are blackish grey, heavily flecked with white and with faint dorsolateral lines; head brown and labials cream.

GEOGRAPHICAL VARIATION

Northern specimens tend to be smaller, less robust, and patternless. South of the Townsville region nearly all are tricarinate mid-dorsally and, north and west of the Townsville region, most are bicarinate. In the Townsville region specimens with mixed bi- and tricarinate dorsal scales occur commonly with specimens having only bicarinate or tricarinate scales.

HABITAT

Grassy areas in open forest, woodland, and on rocky ridges; in southeastern Queensland usually in elevated country.

REMARKS

Mitchell (1953) considered *schmeltzii* a synonym of *Leiopisma fuscum fuscum* but *C. schmeltzii* differs from the *C. fusca* complex in having bi- or tricarinate, mid-body scales, two large squarish ear lobules, and in colour and pattern.

Covacevich and Ingram (1975) described *C. prava* from Kowanyama on the western side of Cape York Peninsula. These specimens were mostly bicarinate and patternless. Although we were familiar with *C. schmeltzii*, we did not compare this species with *C. prava* because *C. schmeltzii* (as it was then understood) was a very large, distinctly marked and coloured, tricarinate skink that apparently varied little. When specimens were collected recently between mid-eastern Queensland and Cape York Peninsula, it became obvious that carination, colour, and size



FIG. 43. *Carlia scirtetis*, Black Trevethan Range, 17km S of Cooktown, NEQ (Queensland Museum).

varied greatly, especially in the specimens from the Townsville region, and that differences used previously to diagnose the species could no longer be maintained. For these reasons it is apparent that *C. prava* is a junior subjective synonym of *C. schmeltzii*.

***Carlia scirtetis* Ingram and Covacevich**
(Figs 9, 43, 44)

1980 *Carlia scirtetis* Ingram and Covacevich. In Bailey, A. and Stevens, N.C., 'Contemporary Cape York Peninsula', p. 45. Black Mountain, Trevethan Range, NE Queensland. Holotype MV D12092.

MATERIAL EXAMINED

QUEENSLAND: Black Mountain, Black Trevethan Range (AM R26719-20; QM J21369-70, 25160, 25935; MV D12091-7, 16581); lower east side of Mt Simon, 'The Black Gap', Black Trevethan Range (AM R64155-68).

DIAGNOSIS

A large (maximum SV 64), dark *Carlia* with smoothly curved posterior edges to the mid-dorsal scales; dorsal and lateral scales mostly weakly tricarinate, with each keel broken into a series of 2-4 smaller points. Distinguished from *C. rimula* by large size (maximum SV 64 vs 39), high midbody scale count (40-45 vs 26-30) and colour and pattern; and from *C. coensis* by its pointed ear lobules, and dark unpatterned juveniles.

DISTRIBUTION

Known only from the exposed boulder mountains of the Trevethan Range, near Cooktown, NE Queensland.

DESCRIPTION

SV: 44-64 (N = 12, mean 53.8), HW: 15-19 (N = 12, mean 16.7), TL: 161-216 (N = 8, mean 181).

Prefrontals separate. Supraciliaries 7, rarely 6 or 8 (N = 9, mean 7.0). Palpebral disc small. Ear aperture usually equal to palpebral disc, longer axis vertical, with many long, pointed lobules around margin. Midbody scale rows 40-45 (N = 12, mean 42.1); mid-dorsal scales with smoothly curved posterior edges, dorsal and lateral scales having 3-4 weak carinations, each carination with a series of 2-4 smaller points. Lamellae under fourth toe 32-37 (N = 12, mean 34.1).

Upperparts dark brown-black with many paler scales, which are sometimes grouped to give the suggestion of faint dorsolateral and vertebral stripes; hind and forelimbs spotted with pale blue; tail with diffuse pale brown dorsolateral lines. Underparts dark; ventral scales bluish and lined in

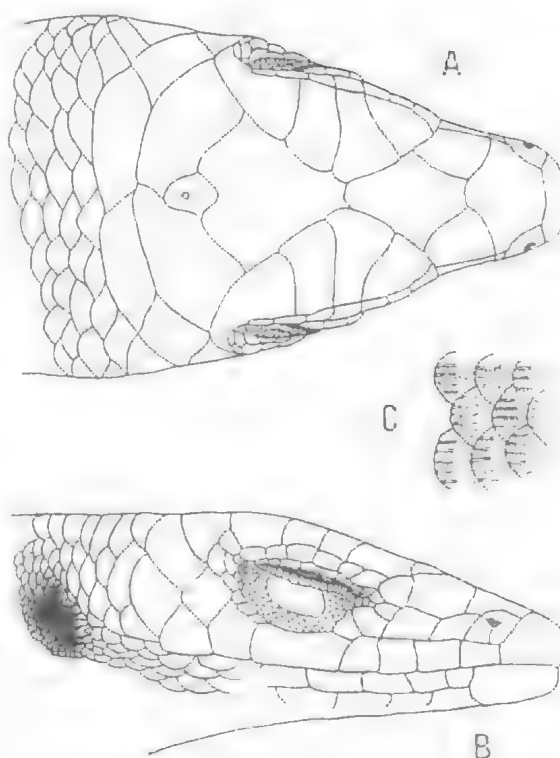


FIG. 44. *Carlia scirtetis* (QM J21370): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

brown; throat, chin, limb and tail scales have heavy brown flecking; undersides of feet black.

HABITAT

Bare black boulders.

REMARKS

Covacevich *et al.* (1982) concluded that *C. scirtetis* was a rare species.

***Carlia storri* sp. nov.**
(Figs 6, 45, 46)

1981 *Carlia storri* Kikkawa, Monteith, and Ingram, p. 1720 (*nomen nudum*).

MATERIAL EXAMINED

HOLOTYPE: QM J24656, Dulhunty River Crossing on Telegraph Road, 110 km S of Bamaga, Cape York, N Queensland (11°50'S, 142°30'E), collected by G.J. Ingram, on 28 September, 1974.

PARATYPES: Murray Island (AM R4508, 44224); Thursday Island (MV D4332); Red Island Point (QM J24639-40); 1.5 km N of Bamaga airport (AM R38643-4, 38646); Lake Boronto (QM J25600); Shotgun Creek crossing (QM J26256); Heathlands (QM J26222);



FIG. 45. *Carlia storri* sp. nov., Chillagoe, NEQ (Steve Wilson).

Dulhunty River crossing (QM J24653-5, 24657-8, 24683-5); Wenlock River at Moreton (AM R38642); 3 km E of west Claudie River on Iron Range road (QM J24691); Iron Range (QM J25429); Claudie River (MV D675, 677-9); Pascoe River crossing on Iron Range Road (QM J24676); 2 km up Lankelly Creek from Coen bridge (QM J26269); 17 km E of Hopevale Mission (QM J17804, 17895-6); Endeavour River (SAM R9746, 9753); Bloomfield River crossing Cooktown (WAM R45606); 5 km S of Cooktown (QM J25312); Shiptons Flat (QM J17908).

OTHER SPECIMENS EXAMINED: PAPUA NEW GUINEA: Maka, Lake Murray (SAM R10557); Balimo, Aramia River (AM R23908, 23913, 23924, 23944, 23970-1, 23973-4, 23977-9, 23981-3, 23987, 23990, 23992-4, 24001, 24005, 24009, 24029-20, 24027-8, 24031-4, 24038, 24044, 24046, 24058, 24060, 24071, 24073, 24081-2, 24085, 24091, 24096, 24108, 24111, 24116-8, 24124, 24128, 24131-4, 24136-7, 24139-40, 24144-6, 24161, 24169, 24172, 24179-80, 24189, 24190; MV D14424; SAM R10292a,b); Extension Station, Oriomo River (AM R23684-5); Daru Island (AM R30663, 30666, 30668, 30672-83, 30699; MV D14483-7, 14497; SAM R10257, 10282, 10288, 10290); Boze, Binatur River (SAM R10556a,b); Sigabadura, West District (AM R40790-1).

QUEENSLAND: Cooktown junction on Mossman to Cairns road (AM R38637); Port Douglas (SAM

R2971a,b, 2976); Mt Frazer (QM J23452, 23454); Mt Molloy (AM R47191; QM J17816, 19409, 19419); 17.7 km S of Mt Carbine (AM R16322); Palm Beach near Cairns (QM J11852; SAM R2974, 2979-80, 2985-7); 22.5 km S of Mt Carbine (AM R38638-40); Cairns (QM J15799, 25550; SAM R2973, 2977, 2983); Rocky Creek between Atherton and Mareeba (QM J18035); 11 km S of Mareeba (AM R26099, 26106); Tinaroo Dam (QM J11582); 8 km S of Gordonvale (AM R26632); Bellenden Ker (QM J579-90); Dunk Island (QM J7779); 14.3 km N of Cardwell (QM J26600); 25.9 km N of Ingham (QM J26601); Hinchinbrook Island (AM R9587; QM J26342); Herbert Gorge (QM J2464-5); 66.3 km NW of Townsville (QM J26557-8); 19.9 km S of Ingham (QM J26607-9); 1.6 km W of Moongobulla (QM J26626-34); 54.3 km NW of Townsville (QM J26567-8); between Townsville and Argea (AM R47192); 29.3 km NW of Townsville (QM J26553-4, 26603).

DIAGNOSIS

A small (maximum SV 46) *Carlia* with strongly bicarinated and hexagonally shaped mid-dorsal scales. Ear aperture with short to long acute lobules around margin. Distinguished from the Timorese *C. spinauris* (data from Greer, 1976) by

more numerous lamellae under fourth toe (usually 27-33 vs 21-25) and dorsal and lateral scales bicarinate; from *C. mundivensis* and *C. johnstonei* by fewer supraciliaries (usually 6 vs 7) and fewer midbody scale rows (27-33 vs 34-42 and 34-38 respectively); from *C. bicarinata* by colouration and pattern (Breeding male; pale brown with orange legs and tail vs dark brown dorsally, laterally, and on limbs, with a red midlateral stripe and white flecking. Females and juveniles; white midlateral, dorsolateral, and pale vertebral lines, the latter two enclosing two darker paravertebral stripes vs white midlateral, dorsolateral and pale paravertebral lines, the latter two enclosing darker vertebral and laterodorsal stripes).

DISTRIBUTION

SW Papua New Guinea, Torres Strait Islands and Cape York Peninsula, south to Townsville. Also, Daru, Dunk and Hinchinbrook Islands.

DESCRIPTION

SV: 21-46 (N = 207, mean 38.7). HW: 12-18 (N = 201, mean 15.0). TL: 141-236 (N = 75, mean 189.0).

Prefrontals separate, rarely contiguous along midline. Supraciliaries usually 6, but commonly 5 or 7. (N = 204, mean 5.9). Palpebral disc small. Ear aperture round, equal to or smaller than

palpebral disc, with short to long acute lobules around margin. Midbody scale rows 27-33 (N = 188, mean 30.1); mid-dorsal scales hexagonally shaped and strongly bicarinate. Lamellae under fourth toe 27-33 (N = 184, mean 30.3).

Colour and pattern varies between two extremes described below. Female: greenish brown to pale brown ground colour, with well defined pale dorsolateral lines from above and behind eyes to along tail; a distinct pale vertebral line from neck to base of tail, and pale midlateral line from above and behind forelimbs to just in front of hindlimbs; dark paravertebral stripes with light speckling; lower lateral surface pale; head coppery brown. Breeding male: pale brown with no pattern and with orange tail and legs. Ventrally white.

In all phases there is a white spot at the posterior base of the thigh which is sometimes connected to a white line that continues along the thigh.

HABITAT

Lowlands, grassy areas in open-forest, woodland and sea shores.

ETYMOLOGY

Named for Dr Glen Storr of Western Australian.

Carlia tetradactyla (O'Shaughnessy) (Figs 25, 47, 48)

1879 *Mocosa tetradactyla* O'Shaughnessy. *Ann. Mag. Nat. Hist.* (5) 4: 300. Queensland?. Holotype BMNH 1946.9.17.43.

1890 *Lygosoma maccooyei* Ramsay and Ogilby. *Rec. Aust. Mus.* 1: 8. Brawlin, N.S.W. Lectotype AM R685 (here designated).

MATERIAL EXAMINED

QUEENSLAND: Kaimkillenbun (AM R11676); Oakey (QM J23997-8, 24053); Cecil Plains (QM J26939); Toowoomba (QM J2631-2); Jolly Falls (QM J21957, 26666); N of Girraween National Park (QM J22762); Storm King Dam (QM J27907-8); Stanthorpe District (QM J21758); 8.5km S of Stanthorpe (QM J11847); 6.4km N of Wallangara (QM J23909); Wyberba (QM J11848); Queensland? (BMNH 1946.9.17.43).

NEW SOUTH WALES: Bruxner Highway, 35km W of Tenterfield (MV D38912); Tenterfield (AM R13121-2); 21km W of Tenterfield (QM J24052); Tamworth (AM R15099); Warrumbungle Mountains (AM R14982, 15573); Coonabarabran (MV R14529); Dubbo (QM J7775-7); Guntawang (AM R4016); 20km W, 16km S of Singleton (AM R49187); 42km W, 18km S of Singleton (AM R49189); Kandos (AM R47195); Turondale (AM R33198); 2km W of Molong (AM R47194); Capertee (AM R27385); Limestone Creek, 11km S of Lyndhurst (MV D14530-1); Brawlin (AM R671-2, 676-7, 683-6, 797).

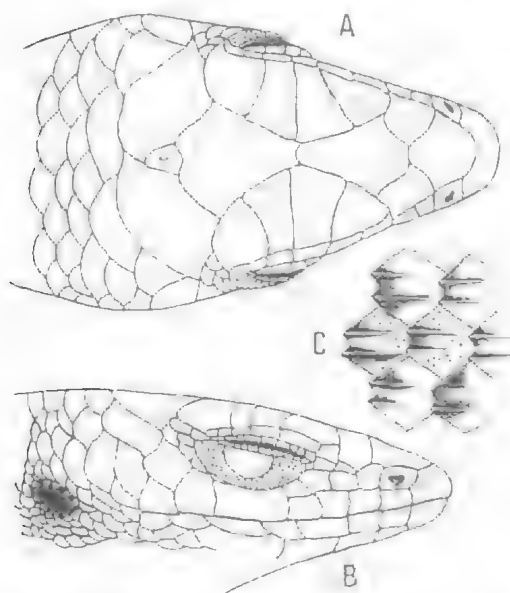


FIG. 46. *Carlia storri* sp. nov. (QM J25600): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.



FIG. 47. *Carlia tetradactyla*, Oakey, SEQ (Queensland Museum).

802, 834-5, 921; BMNH 1946.8.17.76-8); Cootamundra (MCZ 6304); 21km NE of Tarcutta (MV D14528); 17km NE of Tarcutta (MV D14527); 6.4km NE of Tarcutta (MV D14525-6); Tarcutta (MV D14522-4); Pedro River, Moruya (AM R49103, 49105); 17km N of Albury (MV D14636-7); 'Nuruanny', Murrumbidgee (MV D827).

VICTORIA: Barnawatha (AM R4131); Warby Range (MV D14399); Beechworth (MV D42894); 3.2km N of Taminick Gap (MV D14576); Taminick Gap (MV D14563); 1.6km E of Taminick Gap (MV D14616); Benalla (AM R897-8); Victoria (MV D652, 1723); no Data (AM R956).

DIAGNOSIS

A large (maximum SV 64) *Carlia* with smooth or striate mid-dorsal scales with smoothly curved posterior edges; ear aperture round with rounded lobule on anterior margin. Further distinguished from *C. longipes* by lower number of lamellae under fourth toe (usually less than 25 vs usually 27 or more); from *C. munda* by higher number of supraciliaries (usually 7 vs 5), from *C. rhomboidalis* and *C. rubrigularis* by its free interparietal, and from all these species by coloration and pattern.

DISTRIBUTION

Southeastern Queensland to northern Victoria on the western slopes of the Great Dividing Range,

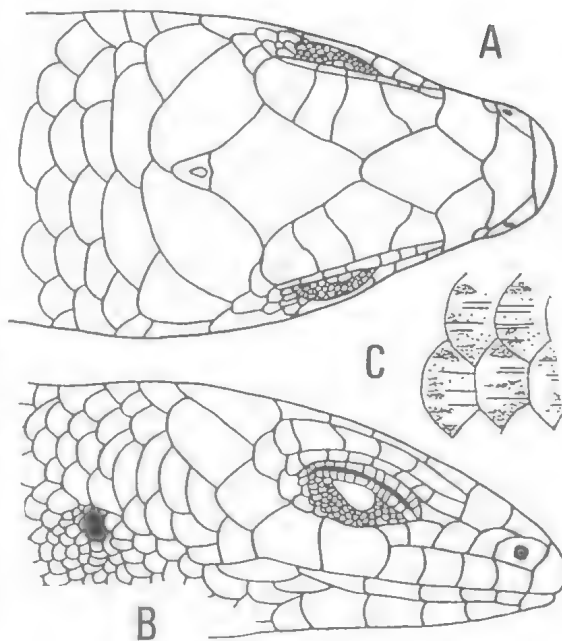


FIG. 48. *Carlia tetradactyla* (QM J21957): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

from Oakey and Cecil Plains in Queensland to Benalla, Victoria. In New South Wales, west to the Warrumbungles, Dubbo, and Cootamundra.

DESCRIPTION

SV: 25-64 (N = 72, mean 49.1). HW: 14-18 (N = 65, mean 16). TL: 30-119 (N = 28, mean 151).

Prefrontals usually separate but touching or forming a median suture in 10% of specimens. Supraciliaries 7, rarely 6 or 8 (N = 134, mean 7.0). Palpebral disc small. Ear aperture round, equal to or smaller than palpebral disc, with usually a larger rounded lobule on the anterior edge with smaller ones on other margins. Midbody scale rows 29-34 (N = 70, mean 31.2); mid-dorsal scales smooth, often striated, and with smoothly curved posterior edges. Lamellae under fourth toe 18-27 (N = 69, mean 22.3).

Ground colour olive-grey; thick dark vertebral stripe from neck to along tail with 2-4 lines of white dotting; a dark stripe along upper lateral surface; upper and lower labials white; in juveniles, a white stripe from ear to above fore limb; bluish-white ventrally. In breeding males two burnt-orange upper and lower lateral stripes between fore limb and hind limb.

HABITAT

Grassy areas in open forest, woodland, and cultivation.

REMARKS

Mitchell (1953) considered *Leiolopisma* *maccooei* (Ramsay and Ogilby) distinct from *L.*

tetradactyla (O'Shaughnessy), giving the separation of prefrontals as the distinguishing feature. Examination of the holotype of *Mocoo tetradactyla* (BMNH 1946.8.17.43) shows that the prefrontals nearly touch. Similarly one of the specimens (QM J2632) examined by Mitchell has prefrontals that are only barely separated. Examination of the twelve syntypes (BMNH 1946.8.17.76-8; MCZ 6304, AM R672, R676-7, R683-6) of *Lygosoma maccooei* confirm Coventry's (1971) suggestion that they and the holotype of *Mocoo tetradactyla* were conspecific. We have chosen AM R685 as the lectotype of *Lygosoma maccooei*.

Carlia triacantha (Mitchell)

(Figs 30,49,50)

1953 *Leiolopisma triacantha* Mitchell. *Rec. S. Aust. Mus.* 11: 88. Adelaide River, Northern Territory. Holotype SAM R2697.

MATERIAL EXAMINED

WESTERN AUSTRALIA: Prince Regent River National Park (WAM R46815, 46817, 46839, 46809, 46965, 46967, 46971, 46763-6, 46742-57, 47243, 46889-90, 46993-4, 47004, 47012, 46950); Drysdale River National Park (WAM R50468-9, 50471, 50555).

NORTHERN TERRITORY: Port Darwin (QM J13690); Adelaide River (SAM R2697); 64km S of Darwin (NTM 1813); Mt Doreen, 59.6km W of Yuendumu; 5.5km N of Pine Creek (NTM 3093-7); Ban Ban Springs (NTM 3133); Katherine (NTM 2174); 32.1km W of Rabbit Flat (NTM 1513); Barrow Creek Roadhouse (AM R52087); Mt Olga (AM R17497).



FIG. 49. *Carlia triacantha*, Manning Ck, WA (Steve Wilson).

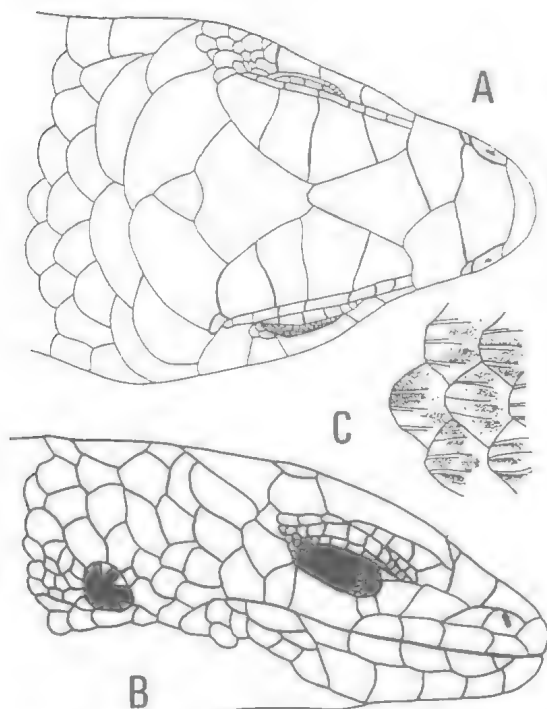


FIG. 50. *Carlia triacantha* (QM J13690): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

DIAGNOSIS

A medium sized (maximum SV 53), robust, *Carlia* with prefrontals usually contacting and forming a suture; mid-dorsal scales usually tricarinate, tending to be tricuspidate, 'quadrangulately' shaped, and irregularly aligned. Further distinguished from *C. pectoralis* and *C. gracilis* by larger number of supraciliaries, (usually 6 vs 5) and also from the latter by its larger palpebral disc (much more than half of eyelid vs about half of eyelid).

DISTRIBUTION

Western Australia north of 23°S, including many continental islands, and the greater part of Northern Territory (see Storr, 1974).

DESCRIPTION

See Storr (1974: 159).

HABITAT

'*C. triacantha* is the *Carlia* of sandstone/spinifex. It has also been found among other rocks, on sand and in termitaria. Its adaptation to dry sites has enabled it to penetrate southwards into the Pilbara and Central Australia' (Storr, *in litt*).

Carlia vivax (de Vis) (Figs 12,51,52)

1884 *Myophila vivax* de Vis. *Proc. Roy. Soc. Qd* 1: 77. Syntypes missing, from Brisbane, Queensland. Neotype, here designated, QM J24176, from Mt Coot-tha, Brisbane, Queensland.

1885 *Heteropus blackmanni* de Vis. *Proc. Roy. Soc. Qd* 1: 168. Port Curtis, Queensland. Lectotype QM J19985 (here designated).

MATERIAL EXAMINED

QUEENSLAND: Prince of Wales Island (AM R46239, 46244, 46249, 46255, 46301, 46314, 46316, 46486, 46614); Horn Island (QM J25493, 25495, AM R59139-41); Coen airfield (AM R16172); 3 km N of Coen (QM J26273); Coen (AM R16526, 38641); 13 km SW of Coen (QM J26285); Melville Range (QM J20514); 3.2 km from Wakooka on Cape Melville Road (QM J20764); Magnificent Creek, Kowanyama (QM J14104, 14106-8, 14110-5; WAM R51177-8); Laura River (QM J11158-60); Low Island (QM J7772); 17 km S of Mt Carbine (AM R16323-4); 22.5 km S of Mt Carbine (AM R38636); Mt Molloy (QM J11713-20, 19415); Stannary Hills (QM J7780-1); Lappa Junction (AM R16673); 23.2 km E of Woodstock (QM J26578); Lindeman Island (AM R9940, 11166, 11168, 47162-4, 47179; QM J5640-1); Homevale (QM J33978); Nebo Creek via Nebo (QM J33943, 33949-50, 33952-60, 33962-3); Curtis Island (QM J24219-20, 24225, 24231, 24238, 24254); Rundle Range (QM J33755-8, 33761-5, 33787, 33790, 33814, 33832, 33834, 33847-8, 33850, 33852); Port Curtis (QM J7773, 19970, 19973, 19980, 19982-5, 19989-90); Gladstone (AM R10078); 12 mile creek N of Bororen (QM J11707, 11710, 11712); 11 km S of Miriam Vale (QM J11731); Warro State Forest (QM J23796, 23839, 23842-5) 9.6 km S of Lowmead (QM J23864); Burnett Heads (AM R49840-1); Bundaberg (QM J22002, 22007, 22319, 22321-2); 5 km SE Carnarvon National Park (QM J24181); Burnett Heads (AM R49840-1); Goodnight Scrub, Burnett River (QM J24949); Coomboo Lake, Fraser Island (QM J22059); 48 km NW of Taroom (QM J24125); Toogoom via Torbanlea (QM J6326, 6328, 6330, 6332); Eidsvold (AM R6007); Upper Burnett River (AM R5494); 40.2 km from Gayndah (QM J11730); Murphys Lake, Taroom (QM J11736); 22.5 km NW of Injune (QM J17726-7); Cooloolia (QM J22474-5, 22481, 22484, 22972, 24178-9, 24183, WAM R45603, 44997-45001); Goomeri (QM J11729; WAM R45604); Noosa Heads (QM J1705, 7806, 11706); Chinchilla (QM J25959); Caloundra (QM J11764); Bribie Island (QM J21759-64); Burpengary (QM J9080); Virginia (QM J21953); Moreton Island (QM J22277, 24175); Pine Rivers (QM J2480-1); Petrie (QM J22671-3, 22676); 8 km N of Wivenhoe (QM J11756-9); Mt Glorious (QM J11743-6); Pt Lookout, N Stradbroke Island (QM J21979, 21984, 24167-8; WAM R45003); Brown Lake, Stradbroke Island (WAM R45002); Brisbane area (QM J1308, 1708, 1711, 2852, 11711, 11724, 11740-2, 11747-51, 11755, 11760-1, 21398, 21950-2, 21974-6, 21986-7, 22006, 22313, 22317, 24003, 24176-7, 24180, 24182, WAM R45005); Lake Manchester (QM



FIG. 51. *Carlia vivax*, Fraser Island, SEQ (David Knowles).

J11725); Myora Springs (QM J24090-2); Peel Island (QM J22367); Brown Lake (QM J24166); 3.2 km W of Mt Crosby (QM J11752-4); Mt Crosby (QM J22718); Daisy Hill (QM J24171-3); between Marburg and Rosewood (QM J11737); Dinmore (QM J22020); Beenleigh (QM J21948); 6.4 km S of Logan Village (QM J13536); Redbank Plains (QM J2853); 3.2 km E of Flinders Peak (QM J11738-9); Tamborine (MV D15307-8); Cedar Creek Falls, Mt Tamborine (QM J11708-9); Mt Tamborine (QM J11762-3); Boonah (QM J11721-2); 12 km S of Nerang (QM J24184); Barney View near Mt Barney (QM J21993-6, 21999); Warwick (QM J13169); Emu Vale (QM J13349-50); Fletcher (MV D124); Texas Caves area (QM J25916-20); Texas (QM J24001); Queensland (MV D1248, 2036).

NEW SOUTH WALES: Ashford (QM J24000); Maclean (AM R15187); 29 km S of Singleton on Putty Road (QM R46015).

DIAGNOSIS

A small (maximum SV 47) *Carlia* with hexagonally shaped and bicarinate mid-dorsal scales; with ear aperture vertically elongate usually with one large rounded anterior lobule. Further distinguished from *C. schmeltzii* by fewer supraciliaries (usually 5 vs 7); from *C. amax* by fewer supraciliaries (usually 5 vs 6); and from *C. pectoralis* pectoralis by less robust shape, pattern and coloration (female and juvenile with white midlateral and dorsolateral lines vs midlateral line only; breeding male with light coloration, bluish throat and side of head, and laterally suffused with pink or with a broad pink midlateral line, vs throat, labials, ventrolateral part of head scales heavily lined in black, with a red upper and lower lateral stripe

which may be broken up into dots); and from *C. p. inconnexa* by colour and pattern, which is heavily black-blotched in females and, in breeding males, black striped longitudinally on the dorsum. For difference from *C. dogare* see diagnosis of that species.

DISTRIBUTION

Prince of Wales and Horn Islands in the Torres Strait, Cape York Peninsula, south to Kowanyama in the west and Mt Molloy in the east through eastern Queensland and New South Wales to Singleton, ME New South Wales; west to Carnarvon Range and Texas in Queensland. Also on Low, Lindeman, Fraser and Moreton Bay islands.

DESCRIPTION

SV: 23-47 (N = 249, mean 37.7). HW: 11-20 (N = 244, mean 15.0). TL: 154-237 (N = 75, mean 193.8).

Prefrontals separated. Supraciliaries 5, rarely 4, 6 or 7 (N = 520, mean 5.0). Palpebral disc very large. Ear aperture smaller than disc, longer axis vertical, usually with one enlarged lobule on anterior margin. Midbody scale rows 23-34 (N = 254, mean 29.7); mid-dorsal scales hexagonally shaped and bicarinate. Lamellae under fourth toe 20-31 (N = 252, mean 25.4).

Colour and pattern vary between the two extremes described below. Juveniles and female — light brown with well defined midlateral and dorsolateral white stripes, often with a paravertebral

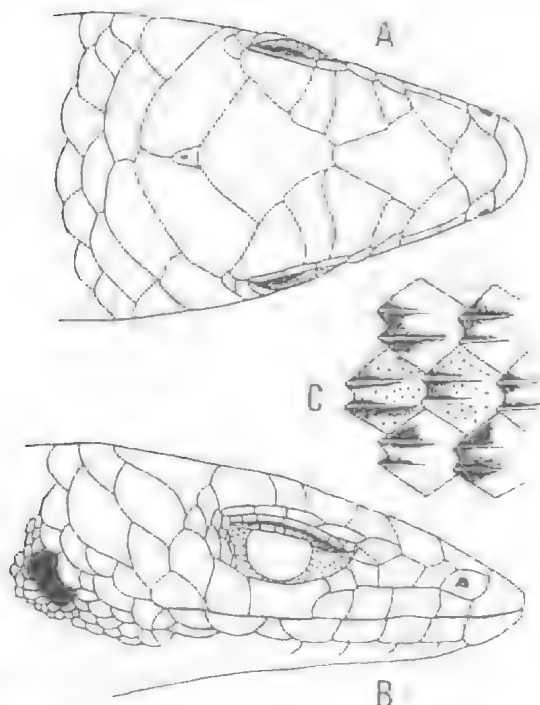


FIG. 52. *Carlia vivax* (QM J14114): A, Dorsal view of head. B, Lateral view of head. C, Mid-dorsal body scales.

series of darker ocellations. Breeding male — light brown with sides suffused with pink or with a thick pink midlateral line; throat blue, specked with dark brown.

GEOGRAPHICAL VARIATION

C. vivax generally exhibit decreases in size and number of midbody scale rows and increases in number of lamellae under fourth toe with decreasing latitude. Pattern varies little over its range but northern Queensland specimens have very distinct, wider, midlateral and dorsolateral white stripes with brown pigments on lateral surface sharply delimited from the white ventral surface.

HABITAT

Grassy areas in open forest, woodland, and agricultural areas. Mostly lowlands.

REMARKS

Although de Vis (1884b) described *Myophila vivax* with a fixed eyelid, the name is easily referred to this taxon. A very large transparent palpebral disc, which is often kept tightly closed giving the appearance of a 'naked' eye, virtually fills the lower eyelid. *Heteropus blackmanni* de Vis was

placed, with question, in the synonymy of *Lygosoma peronii* Duméril and Bibron by Boulenger (1887). De Vis (1888) accepted *blackmanni* as a junior synonym of *peronii* but noted that the latter name was occupied in the genus *Lygosoma*. Zietz (1920) listed *blackmanni* as the available name for *peronii*, while Mittleman (1952) recognized it as a separate species. Mitchell (1953) treated the taxon as a synonym of *peronii* but gave *vivax* as the available name. *Peronii* has been shown since by Greer (1976) to be a senior synonym of *Carlia spinauris* Smith, a species from Timor and nearby islands.

The holotype of *Myophila vivax* has not been located (Covacevich, 1971). To stabilize the nomenclature we have selected a neotype. De Vis's specimen came from Brisbane.

Neotype: QM J24176 Mt Coot-tha, Brisbane, SE Queensland (27°29'S, 152°57'E). Collected by G. Ingram, C. Corben and D. Miller on 25 July, 1973.

SV: 41. **HW:** 15. Tail regenerated.

Prefrontals separated. Supraciliaries 5. Palpebral disc very large. Ear aperture smaller than disc, longer axis vertical, with one enlarged lobule on anterior margin. Midbody scale rows 32; mid-dorsal scales hexagonally shaped and bicarinate. Lamellae under fourth toe 22.

Dorsally and laterally brown, except for two faint darker brown paravertebral stripes and bluish labials. Ventrally yellow except for underside of head, which is blue.

Covacevich (1971) reported the existence of a series of specimens (QM J19968-90) found in a jar labelled 'Cotypes *Heteropus blackmanni*' and another specimen J7773 found in a jar labelled '... probably one of type species ...'. The latter specimen was examined by Mitchell (1953), and it is, as he said, a specimen of *C. vivax*. The series was not examined by him. The register entry for J7773 is 'old coll: taken from series which is probably type material of *Heteropus blackmanni* de Vis'. It seems reasonable to assume that J7773 was removed from the series of specimens now registered as J19968-99. Examination of the 23 specimens labelled 'Cotypes' shows they represent six species: *Lygisaurus foliorum*, J19971; *C. pectoralis*, J19972, 19974, 19976; *C. rubrigularis*, J19987; *C. storri*, J19975, J19977-9, J19981, J19986, J19988; *C. vivax*, J19970, J19973, J19980, J19982-5, J19989-90; *C. munda* J19969; J19968 could not be identified because of its poor condition. J19985, a specimen of *C. vivax*, is selected as the lectotype of *Heteropus blackmanni*.

KEY TO SPECIES OF *CARLIA*

- 1 Interparietal distinct 2
Interparietal fused with frontoparietal 22
- 2(1) Mid-dorsal scales smooth, striated, or feebly keeled with smoothly curved posterior edges 3
Mid-dorsal scales moderately to strongly keeled and hexagonally or quadrangularly shaped 8
- 3(2) Keels of mid-dorsal scales each broken up into 3 to 5 rounded tubercles 6
Keels of mid-dorsal scales not broken up into rounded tubercles 4
- 4(3) Palpebral disc very large, covering much more than half of lower eyelid; white line from under eye inserting on top of ear aperture, recommencing below and continuing backwards, supraciliaries usually 5 or 6 *munda*
Palpebral disc small, equal to about half of lower eyelid; no white line as above; supraciliaries 7 5
- 5(4) Ear aperture vertically elongate with one or more long acute lobules on margins 23
Ear aperture round with at least one short rounded lobule on anterior margin *tetradactyla*
- 6(3) Midbody scale rows 30 or fewer *rimula*
Midbody scale rows 36 or more 7
- 7(6) Ear aperture with small rounded lobules on margins; juveniles sharply achromatically patterned *coensis*
Ear aperture surrounded by long, thin, acute lobules on margins; juveniles dark, unpatterned *scirtetis*
- 8(2) Mid-dorsal scales bicarinate 9
Mid-dorsal scales tricarinate 17
- 9(8) Ear aperture surrounded by pointed lobules on margins; supraciliaries usually 6 or 7 10
Ear aperture with at least one or two larger rounded lobules on anterior margin; supraciliaries usually 5 or 6 .. 13
- 10(9) Supraciliaries usually 7, midbody scale rows usually 34 or more 11
Supraciliaries usually 6 or 7, midbody scale rows usually 33 or less 12
- 11(10) Large dark, mottled tree or rock-dwelling skink (maximum SV 56 mm); snout depressed; from eastern Queensland *mundivensis*
Small dark brown (sometimes flecked with white) ground dwelling skink (maximum SV 43 mm); snout not depressed; Kimberley region Western Australia *johnstonei*
- 12(10) Breeding male pale brown with orange legs and tail. Juvenile and female, pale brown with white mid-lateral, dorsolateral and pale vertebral lines, the latter enclosing darker paravertebral stripes *storri* sp. nov.
Breeding male heavily spotted with blackish brown and flecked with white; reddish tinge to flanks. Juvenile and female, dark brown with well-defined white midlateral and dorso lateral lines; pale paravertebral lines; the dorsolateral and paravertebral lines enclose darker vertebral and laterodorsal stripes *bicarinata*
- 13(9) Ear aperture horizontally elongate, supraciliaries usually 6 *amax*
Ear aperture vertically elongate; supraciliaries usually 5 or 7 14
- 14(13) Supraciliaries usually 7; two large squarish lobules on anterior margin of ear aperture *schmeltzii*
Supraciliaries usually 5; 1 or 2 rounded lobules on anterior margin of ear aperture 15
- 15(14) Juvenile and females with pale vertebral stripe, lamellae under fourth toe usually 29 or more; ear black *dogare*
Juveniles and females with no pale vertebral stripe, lamellae under fourth toe usually less than 29; no black ear 16
- 16(15) Juveniles and females pale brown, with white dorsolateral line; breeding male pale brown with blue throat, pink sides or thick pink midlateral stripe *vivax*
Juveniles and females dark, with no dorsolateral stripe; breeding male dark, with two red lateral stripes; the lower one can be broken up into dots; scales on throat and side of head edged in black. On the Whitsunday Island Group, females strongly blotched with black and breeding males with a series of up to 10 black longitudinal dorsal stripes *pectoralis*
- 17(8) Palpebral disc small, occupying about half lower eyelid; ear aperture about same size as disc 18
Palpebral disc large, occupying much more than half of lower eyelid; ear aperture much smaller than disc 19
- 18(17) Supraciliaries usually 7; ear aperture ver-

- tically elongate 24
Supraciliaries usually 5; ear aperture horizontally elongate..... *gracilis*
- 19(17) Ear aperture horizontally elongate, mid-dorsal scales moderately keeled; supraciliaries 6 or 7..... 20
Ear aperture round or vertically elongate; mid-dorsal scales strongly keeled; supraciliaries usually 5 or 6 21
- 20(19) Juvenile and female with a distinct white line outlined in black from eye to hind leg; breeding male with 5 to 7 blue dorsal stripes, dark blue upper lateral stripe flanked with white, and a red stripe below this..... *jarnoldae*
Juvenile and female with a whitish stripe from under eye to ear and occasionally to foreleg. Breeding male with red mid-lateral stripe *rufilatus*
- 21(19) Prefrontals usually in contact; mid-dorsal scales tricuspid, quadrangularly-shaped so that keels are not aligned; usually 6 supraciliaries *triacantha*
Prefrontals narrowly to widely separated; mid-dorsal scales tricarinate, hexagonally shaped so that the keels are well aligned to form more or less continuous lines along body; usually 5 supraciliaries *pectoralis*
- 22(1) Throat and neck colour blue and pink *rhomboidalis*
Throat and neck colour pink only..... *rubrigularis* sp. nov.
- 23(5) Males boldly marked with black throat, black speckled back, black upper lateral stripe continuing to near hind limb, and red below the stripe, females boldly marked with distinct white dorsolateral stripes and midlateral stripes continuing to behind forelimb *rostralis*
Comparatively drably marked with white throat, brown back, black upper lateral stripe continuing to forelimb, and red or brown sides *longipes*
- 24(18) Ear aperture with 9-16 short to long, pointed lobules around margin..... *mundivensis*
Ear aperture with usually two large squarish lobules on anterior margin *schmeltzii*

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SOME ABERRANT EXOSKELETONS FROM FOSSIL AND LIVING ARTHROPODS

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Aberrant exoskeletons of the Recent xiphosuran *Limulus polyphemus* from New York and the spanner crab *Ranina ranina* from Moreton Bay, Queensland are described. Aberrant exoskeletons are described in several trilobites, namely, the Devonian scutelluid *Spiniscutellum umbelliferum* from Czechoslovakia, the Middle Cambrian eodiscoid *Pagetia silicunda* from western New South Wales, the Middle Cambrian proasaphiscids *Maotunia distincta* and *Eymekops hermius* from northeastern China, the Middle Cambrian mapaniid *Mapania striata* from northeastern China, and the Middle Cambrian ptychoparioid *Papyriaspis lanceola* from northwestern Queensland. Possible causes of the abnormalities are discussed and an attempt made to categorize these specimens with previously described abnormalities. A specimen of the dalmanitid trilobite *Odontochile formosa* with a starfish on its pygidium and posterior part of its thorax is illustrated as a possible example of a predator at work near the Silurian-Devonian boundary.

□ Trilobita, Crustacea, Xiphosura, abnormal exoskeletons.

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Abnormalities in trilobite exoskeletons have been attributed to developmental malfunction, parasitism, or injury. A wide range of subcategories may be defined (e.g. Snajdr, 1978) but these remain the central causes. The degree of abnormality varies considerably; it may cause death, may disappear through a series of moults if inflicted on a juvenile individual, or, in the case of parasitism, may increase with growth. Recognition of the causes is not always simple and it is hoped that closer comparisons with abnormal arthropods living today may provide uniformitarian bases for identifying some causes although Conway Morris and Jenkins (1985) expressed reservations about such an approach. An extensive literature has developed on the subject (listed Boucot, 1981; see also Rudkin, 1985, Conway Morris, 1981) but documentation of further examples will add to understanding of life histories and palaeoecology. Several examples of observed or potential abnormalities in trilobites and in Recent Crustacea and Xiphosura are here described and their causes discussed.

Specimens are housed in the Palaeontology Collections of the Queensland Museum (prefix QMF), Museum of Victoria (NMVP), Department of Geology, Australian National University (ANU), Australian Museum, Sydney (AMF), and the Smithsonian Institution (USNM) and in the Crustacea Collection of the Queensland Museum (QMW).

Limulus polyphemus (Linnaeus, 1758) (Fig. 1)

A moulted but articulated carapace from the shore of Flax Pond at Stony Brook on the north shore of Long Island, New York shows major distortion to the left side of the cephalothorax anteriorly and to the left side of the abdomen. On the cephalothorax the distortion takes the form of a strong buckling of the margin with consequent buckling and twisting of the inner ridge of the doublure. This buckling has not prevented the exoskeleton splitting during moulting along the usual line, just ventral to the margin. The deformity extends to the midline around the anterior median process. On the abdomen, the distortion is in the number of marginal spines (5 on the left; 7 on the right) but otherwise bilateral symmetry appears to be intact.

Both these distortions may have been caused by mechanical deformation of the animal immediately after an earlier (probably very early) moult, while the shell was still soft. The cephalothorax may have recovered some of its original shape during subsequent moults but its departure from the normal is still marked. The original damage to the abdomen may have been to cells involved in developing the lateral spines. Whereas the shape of the abdomen returned almost to normal with growth the damaged cells resulted in loss of capacity to generate some of the lateral spines and those that were produced are smaller than usual.

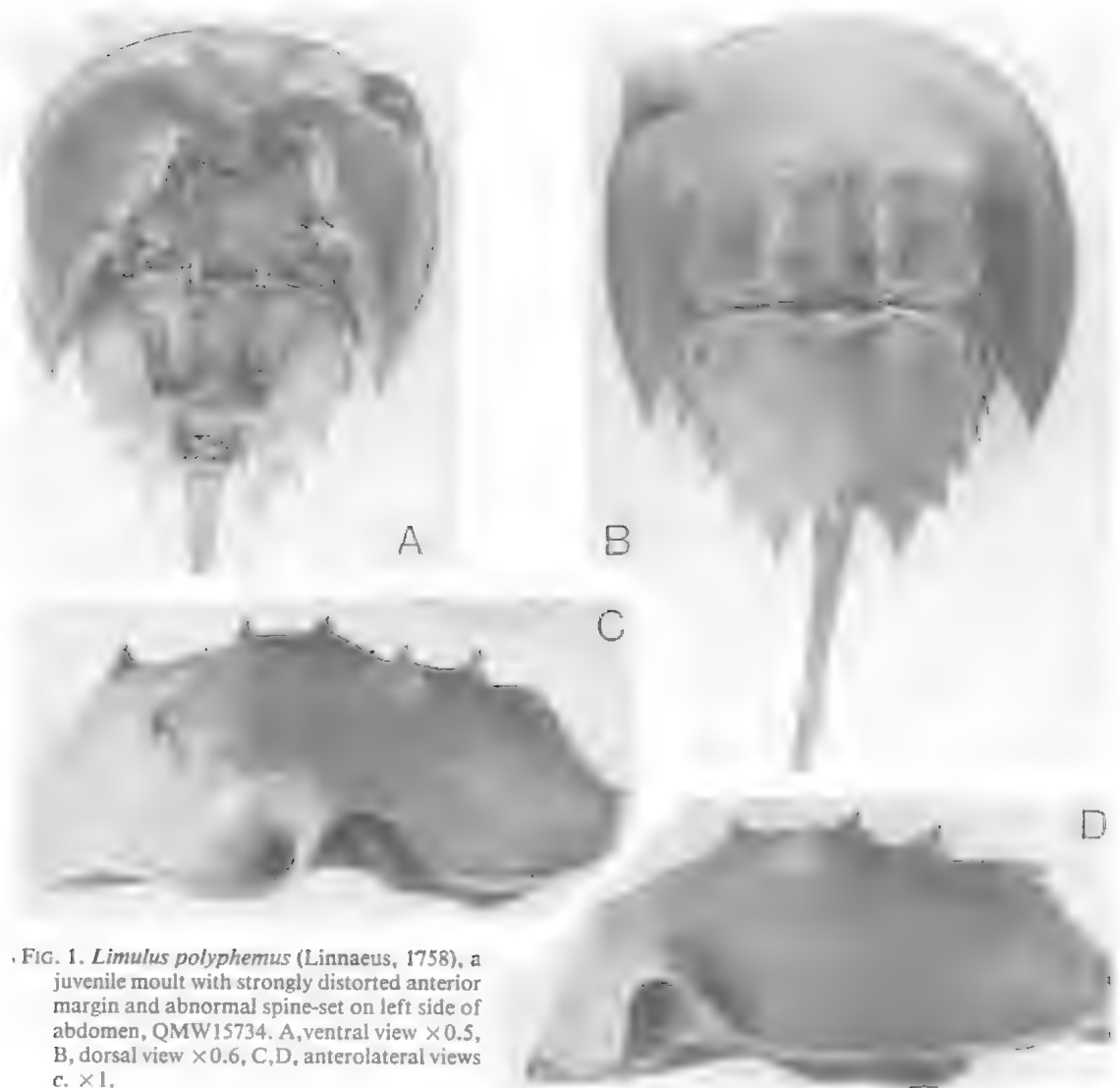


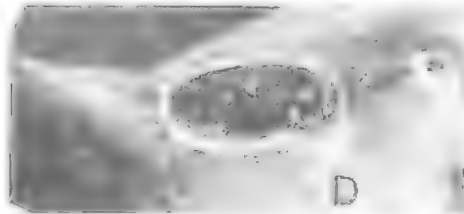
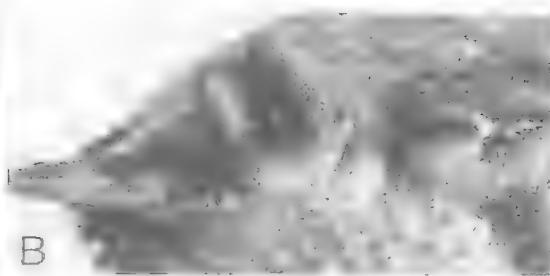
FIG. 1. *Limulus polyphemus* (Linnaeus, 1758), a juvenile moult with strongly distorted anterior margin and abnormal spine-set on left side of abdomen, QMW15734. A, ventral view $\times 0.5$, B, dorsal view $\times 0.6$, C, D, anterolateral views c. $\times 1$.

Since none of the margin was lost in the damage it is unlikely that a predator was involved. It seems likely that this sort of deformity could be caused by mechanical damage to the animal, e.g., by the animal being washed against rocks by wave action or by storm activity.

***Ranina ranina* Linnaeus, 1758**
(Fig. 2)

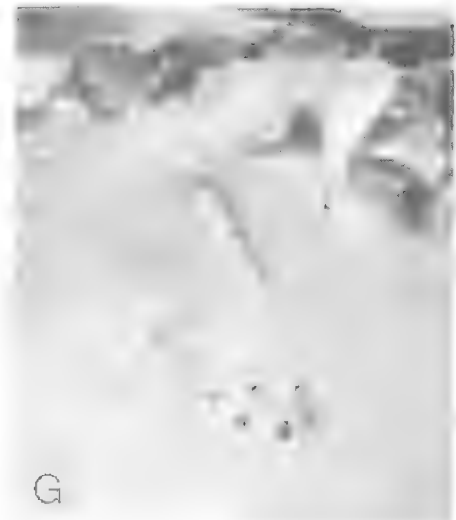
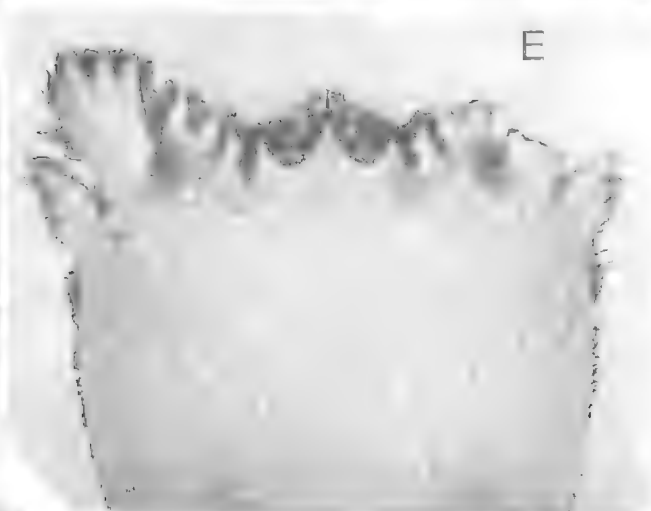
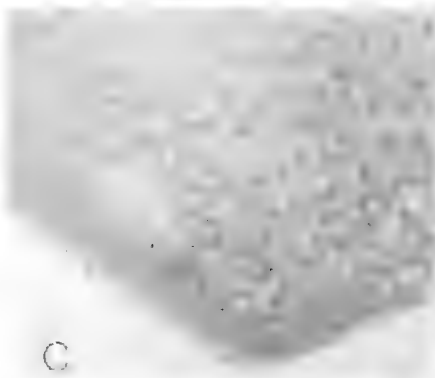
Carapaces of spanner crabs from Moreton Bay exhibit broken or lost spines on the anterior margin, and piercement of the carapace away from the margin are common with or without healing of the wound. Spanner crabs are taken commercially in considerable numbers (of the order of 30-40 per m^2) generally in 30-40m depths and generally without any other large species associated so I suggest that most of the injuries are

FIG. 2. *Ranina ranina* Linnaeus, 1758. A-C, carapace showing damaged right lateral process subsequently healed (B), and rounded bulge posteriorly (C), QMW15735, $\times 0.5$, $\times 2$, and $\times 1$, respectively. D, E, carapace with largest projection on right side broken off (E), and black tissue produced in fracture (D), QMW15736, $\times 0.65$, and $\times 2$, respectively. F, G, carapace in dorsal (F), and ventral (G) views, showing piercement of shell and subsequent initial stage of repair inside, QMW15737, $\times 0.5$, and $\times 2$, respectively.



D

E



inflicted by other members of the same species. To my knowledge injury of one individual by another has not been observed but I can see no other reasonable explanation. One specimen (Fig. 2A,C) also shows a local bulge posteromedially to the left of the midline, the bulge retaining the external ornament but being smooth on the inside.

The latter feature may have resulted from the carapace growing over a parasite beneath the epiderm. This bulge is akin to that seen in free cheeks of *Paradoxides oelandicus* (Westergård, 1936, fig. 8) and *P. sjogreni* (Westergård, 1936, pl.10). These fossil examples are flatter and smaller probably representing a different parasite group.

Fractures of the exoskeleton or removal of whole or partial spines in *R. ranina* show clearly the steps in wound repair outlined by J.R. Stevenson (1985, p. 31) where the break blackens due to melanin (Fig. 2D), epidermal cells form a layer of cells under the blackened membrane and the new shell covers the break on the inside (Fig. 2G). Subsequent moults lose the black layer and new shell, albeit quite deformed, is deposited over the wound (Fig. 2B).

This type of repair observed in living crustacean species may be the same as that in trilobites such as the *Mapania striata* specimen described above or the specimens of *Oxygopsis klotzi* (Rudkin, 1979), *Radioscutellum intermixtum* (Petr, 1983) or *Ceraurinaella* sp. nov. (Ludvigsen, 1977). Only the last example shows the same early stage of damage as the specimen in Fig. 2F,G. Moreover, these injured spanner crabs suggest that within trilobite communities, injuries may have been caused by one individual upon another although the walking legs of trilobites, as far as we know them, may not have been as effective weapons as chelae are on crabs. Such damage may not always be due to predation but may be due to competition within a species.

***Spiniscutellum umbelliferum* (Beyrich, 1845)
(Fig. 3)**

This large pygidium of the Family Scutelluidae from the Devonian Lochkov Shale in Czechoslovakia, has a large indentation in the lateral margin, disrupting pleural ribs and furrows. It may be significant that the second pleural rib is curved adaxially near its outer extremity so as almost to enclose the end of the third rib. The third rib is cut off and the fourth is damaged adaxial to the inner edge of the doublure with the damaged area extending more than a centimetre from the damaged margin.



FIG. 3. *Spiniscutellum umbelliferum* (Beyrich, 1845), a large pygidium with abnormal lefthand marginal area, NMVP63735, $\times 2$.

The origin of this abnormality is not clear. The standard explanations are an encounter with a predator, a mechanical accident such as being rolled around in a storm or being crushed by a heavily armoured animal or a rock. If one of these were the cause then a considerable amount of regeneration has taken place as a large part of the wound has grown over. Regeneration is suggested in the related scutelluid *Radioscutellum intermixtum* illustrated by Petr (1983). His dorsal external mould of the pygidium shows no deformation of the pleural ribs which run up to the ragged margin of the damage and no damage away from the margin. This evidence suggests that the specimen was damaged mechanically by a predator or other agency that took out cleanly a part of the exoskeleton and the damage is thus pathological rather than teratological as suggested by Petr.

My preferred explanation for the abnormality of NMVP63735 is that during moulting a part of the pygidium between dorsal exoskeleton and doublure failed to separate readily from the exoskeleton. This is a possibility in forms such as *S. umbelliferum* with wide doublures situated close to the dorsal exoskeleton. Having released from

most of its shell the animal may be trapped and begin to panic with pain from the struggle. Vigorous activity to be free of the shell may well have torn away a patch of the soft tissue with the shell. In this frenzy the animal would still try to pull soft parts out of the thin space above the doublure towards the axis. As this would have been done while the body was without a hard shell the outer margin of the soft body may have been drawn towards the axis, causing an embayment and curving the anterior pleurae. This deformity may then have been incorporated into the newly hardening exoskeleton. Accordingly I suggest that the abnormality in NMVP63735 was due to malfunction in the process of ecdysis in the centrally deformed part of the abnormality.

Pagetia silicunda Jell, 1975
(Fig. 4)

Among a large population of this early Middle Cambrian eodiscoid from the Coonigan Formation in western New South Wales, a cranidium (Fig. 4A,B) shows a cranial spine broken off near its base and grown over. Another specimen (Fig. 4C) with fully developed spine illustrates the extent of modification. Although mechanical damage cannot be ruled out it seems unlikely in such a small, planktonic species. The confined space within the cranial spine would have been tight for retraction of the soft tissue

during moulting and imperfection in release of the old exoskeleton may have induced the animal to tear off the soft tissue to be free of the molted exoskeleton. The exoskeleton subsequently laid down would lack the extension of the spine and cover the torn area as the wound healed.

A pygidium (Fig. 4D) of the same species was interpreted (Jell, 1975, p.25) as a pathological specimen deformed by a disease or a parasite. This interpretation was based on the fact that the margin intact and the deformity in the left pleura and axis is entirely divorced from the margin. Similar (i.e. isolated from the margin) abnormalities in pygidial symmetry have been accorded differing origins by (Rudkin, 1985, figs 1C, 2). In *Pseudogygites latimarginatus* (Hall, 1847) Rudkin suggested that such a 'point wound' may have been inflicted by a co-occurring nautiloid whereas in *Proetus macrocephalus* (Hall, 1888) the less localized deformity was attributed to major developmental malfunction. In the pygidium of *P. silicunda* the latter cause would seem most probable but the way in which this might have happened and the effect on the animal are not clear.

Maotunia distincta (Resser and Endo, 1937)
(Fig. 5A)

Among a large number of specimens of this proasaphiscid from the *Crepicephalina* Zone, Changhia Formation on Changxingdao Island, Liaoning this cranidium has an aberrant bulge in the anterior border furrow on the left hand side. This bulge is low, smooth, imperforate, elongate in the direction of the furrow and with irregular outline including low ridges that appear to continue into the major caecal trunk (i.e. the expression in the exoskeleton of a major blood vessel adpressed on the inner surface and attributed a secondary respiratory function (Jell, 1978)) in the border furrow and forward into the border. This bulge resembles those on European paradoxidids (Snajdr, 1978, pls 7,8) except that it does not exhibit a central perforation and apparently bears some relationship to the caecal system. It is identical to those on a pygidium of *Eymekops hermias* described below from the same locality and horizon.

These bulges on the Chinese specimens probably resulted from the activity of a parasite, the nature of which is uncertain. If it was an ectoparasite then it must have attached to the animal immediately after a moult so that the exoskeleton has grown over it and been deformed. It is also possible that this feature resulted from a diseased caecum or an

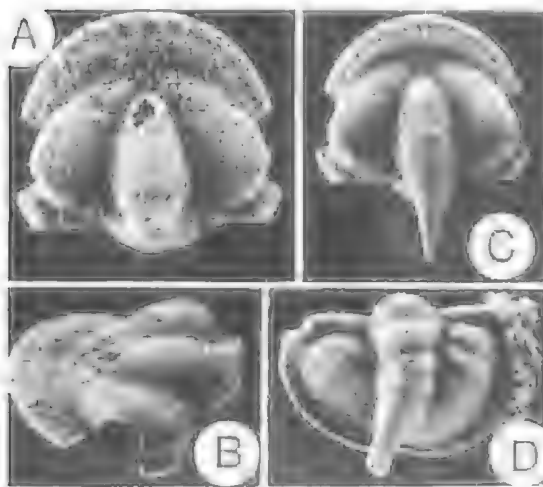


FIG. 4. *Pagetia silicunda* Jell, 1975. A,B, dorsal and lateral views of cranidium with broken but healed occipital spine, ANU27937, $\times 15$. C, undamaged holotype cranidium, ANU27797, $\times 12$. D, pygidium with abnormal left pleura and axis, AMF54980, $\times 15$.



FIG. 5. A, *Maotunia distincta* (Resser and Endo, 1937), cranidium showing caecum with aberrant bulge on left in anterior border furrow, USNM258672, $\times 5$. B, *Mapania striata* Resser and Endo in Kobayashi, 1935, flattened pygidium in shale with damaged right pleural area, USNM258776, $\times 3$. C,D, *Eymekops hermias* (Walcott, 1911), pygidia without (C) and with (D) abnormal bulges posteriorly, USNM258702 and USNM258699, respectively, $\times 10$.

endoparasite in the caecum as suggested by the fact that the 5 examples available all appear to be associated with the caecal system. This is in contrast to those nodes interpreted by Snajdr (1978) as of parasitic origin; their random distribution and circular shape suggest that they were caused by ectoparasites and their common occurrence in the protective hollows of pleural furrows supports this view. It is not possible to tell whether the abnormalities result from a disease in the structure forcing the exoskeleton to grow into a bulge to accommodate it, or whether they are the result of endoparasites lodged in that respiratory system causing enlargement of the caecum and bulging of the exoskeleton around it. At present I would suggest the latter only because I would expect abnormalities in development to be more elongate.

Eymekops hermias (Walcott, 1911)
(Fig. 5C,D)

On a pygidium (Fig. 5D) 4 large bulges (or nodes, in Snajdr's (1978) terminology) and numerous enlarged caeca across the posterior are of irregular shape, smooth, and appear to extend outwards as low ridges into the caecal network. By comparison with other pygidia of this species (Fig. 5C) these bulges are aberrant. Although 2 of the large bulges (one at posterior of axis and one on far left) appear to have small perforations close examination shows these to be irregular around their margins and therefore almost certainly the result of damage to the specimen during or after collection. These bulges are judged to be caused by an agent similar to that which affected the cranidium of *Maotunia distincta* described above. Speculation on the cause is detailed under that species above.

Mapania striata Resser and Endo, 1935
(Fig. 5B)

A pygidium crushed in shale of the Changhia Formation (*Amphoton* Zone) on Changxingdao Island, Liaoning has part of its right pleural area missing. There is a ragged edge to the pleural area over the anterior 4 segments of the pygidium. The

doublure is removed although an extremely narrow doublure appears to have regrown on the 2 anterior segments. There appears to be little distortion of the exoskeleton adjacent to the missing parts; the most logical conclusion is that a part of the pleural field was actually removed probably by the bite of an unknown predator or less likely by a pure accident. Healing of the injury in the form of growing a new doublure puts this specimen in the same class as those described by Rudkin (1979) of *Ogygopsis klotzi*. I agree with Rudkin's interpretation of such injuries. No large predator capable of inflicting such a wound is known from the Middle Cambrian of north China.

***Papyriaspis lanceola* Whitehouse, 1939**
(Fig. 6)

One specimen lacking the cephalon, from the Middle Cambrian V Creek limestone of *Ptychagnostus punctuosus* Zone age on the Camooweal to Burketown road at the crossing of V Creek shows two types of distortion not seen on the immediately adjacent specimen of the same species. On the left side, the last 3 thoracic segments are strongly embayed with callous development around the margin of the embayment. This embayment is similar to that on *Olenellus robsonensis* (Burling) (Rudkin, 1979, fig 2B) and to those in *Ogygopsis klotzi* (Rudkin, 1979, fig. 1).

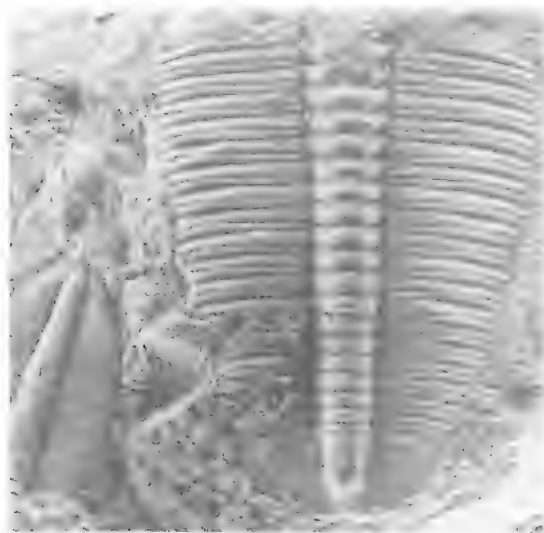


FIG. 6. *Papyriaspis lanceola* Whitehouse, 1936, large thorax and pygidium with last 4 segments abnormal on both sides (small normal thorax and pygidium on same slab with cranidium of *Maotunia angusta* (Whitehouse, 1939) as well) QMF17442, $\times 1$.

It is well healed and so the animal has completed at least one moult after the damage occurred. The original outline of the damage may not have been so well rounded. As this species had a very thin shell (Jell, 1978) the damage may have been caused by some agency that was not particularly violent e.g. some other trilobite of heavier build may have torn the exoskeleton and tissue with a genal or pygidial spine during either chance encounter, mating or assault.

On the right side the 4 posterior thoracic segments each exhibit an irregular node in different places, without obvious damage to the margin. Whereas these nodes could be classified with those described by Snajdr (1978) as of parasitic origin on paradoxidids, I suggest they more probably resulted from damage to the exoskeleton caused during the same incident that damaged the left side. With at least one subsequent moult, the damage has been almost obliterated by growth of the new exoskeleton leaving only these nodes which resemble those near the margin on the left side. The cause of these nodes is equivocal showing how difficult interpretation is in these cases.

***Odontochile formosa* Gill, 1948**
(Fig. 7)

Mainly because of their habit today most starfish have long been reputed to be predatory in the Palaeozoic, though little fossil evidence has ever been brought to light to support this contention. The present specimen comes from the Clonbinane Sandstone Member (Ludlow) of the Humevale Formation at Museum of Victoria fossil locality NMVPL300 in the vicinity of an old mine on Comet Creek, c. 4.6km southeast of Clonbinane, central Victoria. Hundreds of complete starfish and brittlestars, articulated brachiopods and whole trilobites are known from the same locality. I interpret this fauna as probably displaced by catastrophic sediment movement and buried alive. Therefore the association illustrated, of a complete trilobite and starfish, may be fortuitous but it is more likely that the starfish is attacking the trilobite because so much of the starfish is in direct contact with the trilobite exoskeleton. Damage to the exoskeleton is not certain but the arm of the starfish pointing to the posterior of the trilobite appears to be where the exoskeleton should be, and may indicate that part of the exoskeleton had been removed already.

Although it is difficult to be certain of the interpretation of associated fossils this example appears

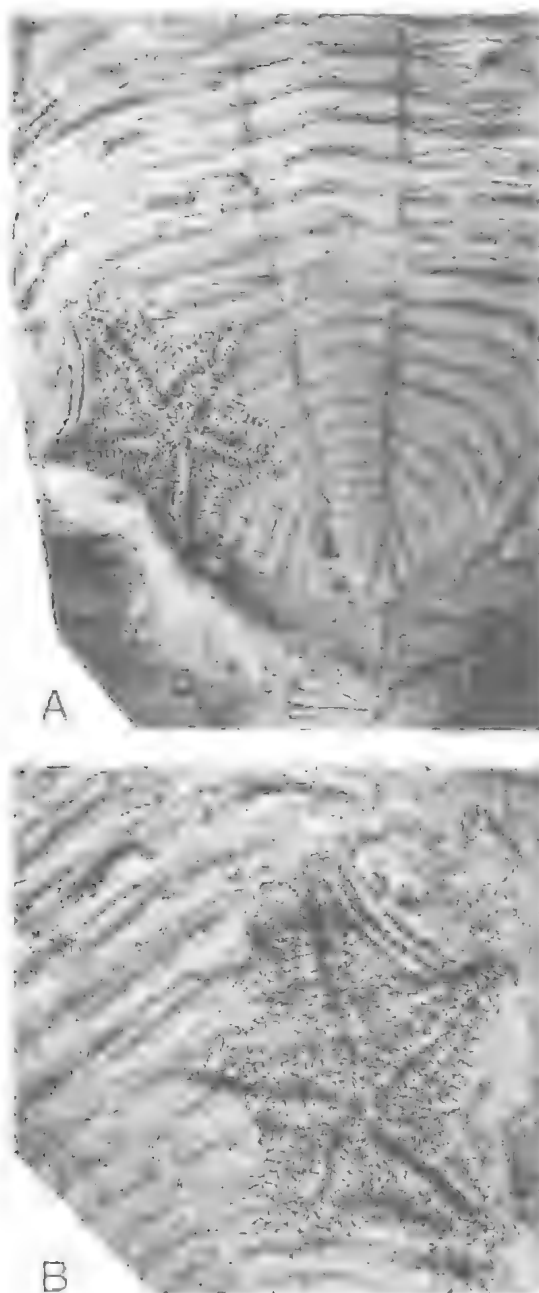


FIG. 7. *Odontochile formosa* Gill, 1948, a large thorax and pygidium with a relatively small, undescribed starfish resting on the pygidium, NMVP113343, $\times 0.5$. A, internal mould of ventral (or oral) surface of starfish and of dorsal surface of trilobite; posterior arm of starfish at lower left. B, ventral view of latex cast of ventral surface of starfish (axis of trilobite pygidium along lower left diagonal of print and posterior arm of starfish in lower right).

to be one of the most direct pieces of evidence so far found for starfish acting as predators in the Palaeozoic.

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RAKAIA DAVIESAE SP. NOV. (OPILIONES, CYPHOPHTHALMI, PETTALIDAE) FROM AUSTRALIA

CHRISTIAN JUBERTHIE

Juberthie, C. 1989 11 13: *Rakaia daviesae* sp. nov. (Opiliones, Cyphophthalmi, Pettalidae) from Australia. *Mem. Qd Mus.* 27(2): 499-507. Brisbane. ISSN 0079-8835.

Rakaia daviesae sp. nov. is from the rainforest of NE Queensland, Australia. The new species has the dorsal side of the single element of tarsus IV of the male divided, and is intermediate between the character states of *Neopurcellia* and *Rakaia*. I retain *Rakaia* and *Neopurcellia* as valid genera. The Pettalidae, limited to *Chileogovea*, *Pettalus*, *Purcellia*, *Rakaia*, *Austropurcellia* and *Neopurcellia*, is a homogeneous family separable from Sironidae by the presence of two kinds of teeth on the moveable finger of chelicerae. However, the relationship of several other African and New Caledonian species (*Parapurcellia*, *Marwe*, *Troglosiro*) which show the main character of Sironidae (one type of teeth), remain an open problem so that the clade, Sironidae-Pettalidae, is probably a limited view of a more complex phylogeny.

L'auteur décrit *Rakaia daviesae* sp. nov. des forêts tropicales du nord-est du Queensland, Australie. Le tarse IV du ♂ est formé d'un article unique, en partie divisé par un sillon transversal dorsal; c'est un trait intermédiaire entre *Rakaia* (1 article) et *Neopurcellia* (2 articles), mais les deux genres semblent valables.

Les Pettalidae, limités à *Chileogovea*, *Pettalus*, *Purcellia*, *Rakaia*, *Austropurcellia* et *Neopurcellia* forment une famille homogène, distincte des Sironidae par la présence de 2 types de dents au doigt mobile des chélicères. Cependant, la position phylogénique d'autres genres africains (*Parapurcellia*, *Marwe*) et de Nouvelle-Calédonie (*Troglosiro*) est difficile à établir; de ce fait, la distinction Sironidae-Pettalidae est peut-être une vue limitée d'une phylogénie plus complexe.

□ *Rakaia daviesae*, Opiliones, Pettalidae, Queensland, Australia.

Christian Juberthie, Laboratoire Souterrain, Centre National de la Recherche Scientifique, Moulis, 09200 Saint-Girons, France; 20 March, 1988.

Four genera of Cyphophthalmi have been described from Australia, New Zealand and New Caledonia: *Rakaia* Hirst, 1925, *Neopurcellia* Forster, 1948, *Troglosiro* Juberthie, 1979, and *Austropurcellia* Juberthie, 1988. Forster (1948, 1952) described 20 species of *Rakaia* and 3 species of *Neopurcellia* from New Zealand and recorded the first cyphophthalmid from Australia: *Rakaia woodwardi* Forster, 1955. Two further Australian species, *Neopurcellia capricornia* Davies, 1977, and *Rakaia arctica* Cantrell, 1980, have been described. *Troglosiro* has not been found outside New Caledonia.

All the Australian species of the Cyphophthalmi have been found in tropical Queensland. In this paper, I describe a new species, *Rakaia daviesae* from that region. All the specimens examined are in the Queensland Museum (QM). Several other new species will be described in a further paper.

Rakaia Hirst

Since the description of *Rakaia woodwardi* by Forster (1955), numerous new delicate characters have come into use for the description of Cyphophthalmi, and it is necessary to add more detail to

the generic description of *Rakaia* based on examination of *R. antipodiana* Hirst, *R. woodwardi* Forster and *R. daviesae* sp. nov. Metatarsi I and II have only dorsal and dorsolateral surfaces granulate, otherwise smooth (Forster — 'Metatarsi I and II entirely granulate'). Movable finger of chelicera with two kinds of teeth. Sternite 8, sternite 9 and tergite IX (together forming the corona analis) distinct in all species. Anal glands present in male. Ovipositor with subapical sensory process. These latter two characters were not confirmed in the type species, *R. antipodiana*.

***Rakaia daviesae* sp. nov.**
(Figs 1-7)

MATERIAL EXAMINED

HOLOTYPE: ♂, sieved litter, rainforest, 10 m, Graham Range, NE Queensland (QM Berlesate No. 3, 17°17'S, 145°57'E), G.B. Monteith, 9 Apr. 1979. QM S6441.

ALLOTYPE: ♀, same data as above. QM S6442.

PARATYPES: 2 ♂, 3 ♀, same data as above. QM S6443.

DESCRIPTION OF MALE

Colour: Dark reddish-brown body; red brown

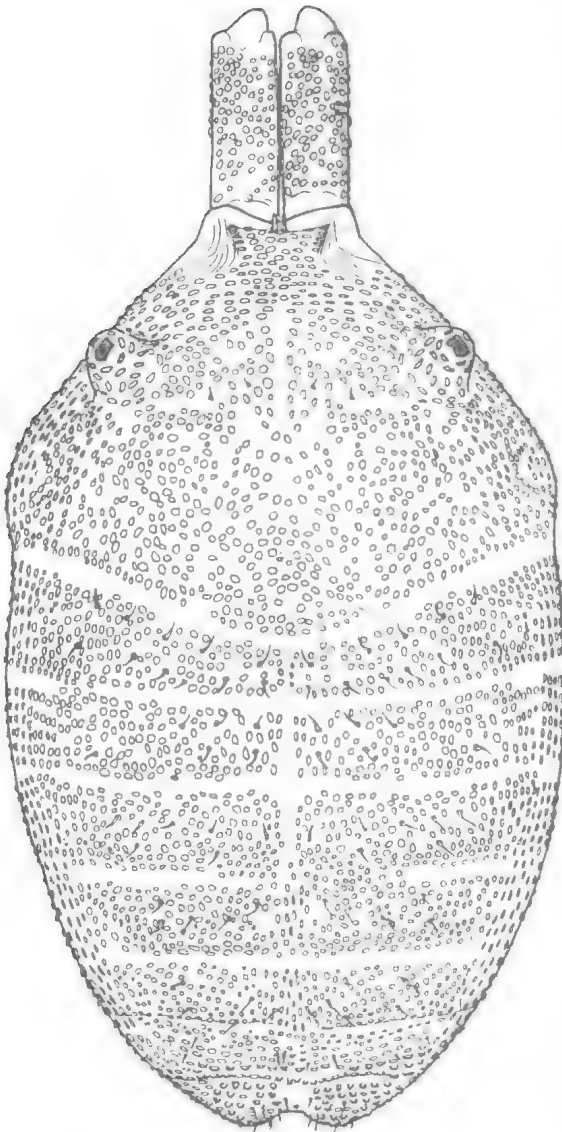


FIG. 1. Habitus of ♂ *Rakaia daviesae* sp. nov.

chelicerae; light yellow brown appendages and tubercles of the odoriferous glands.

Body: Body length 2.00 mm; greatest width, measured at opisthosoma, 1.15 mm (Fig. 1).

Dorsal shield completely fused. Surface granulate; tergites clearly defined by straight transverse grooves which are areas without granules and with only very small thorns; a shallow median groove separates each of the first three tergites. On tergite IV this groove has a blurred outline because several elongate granulations are present, and it disappears on tergites V–VII.

Setation sparse on prosoma; two transverse rows of 4, 5 or 6 short setae on each side of tergites I–IV, irregular in position and number on the others. Medio-anterior part of cephalothorax (prosoma) with a short median projection bearing basal segment of chelicerae; lateral parts of the projection not granulate.

Tergite VIII with a pronounced median groove without granulations and scopulae. One sagittal opening of anal gland in the median groove of tergite VIII (Figs 1–3). Twin parasagittal openings of other anal glands between tergites VIII and IX (Figs 2,3). On each side of the groove 6–8 setae (same type as other tergites) that do not form a tuft.

Odoriferous gland mounds conical, nearly vertical, set a distance equal to half of their diameter from lateral margins of dorsal shield. In dorsal view, apical part of the mounds projects beyond margin of scutum.

Coxae I and II free (Fig. 3a). Coxae III and IV fused in midline. Aperture of coxal glands between coxae III and IV. Coxae IV delineate anterior part of genital aperture. Sternites with short setae all of the same type. Corona analis (Fig. 3b and c). Sternite 9 free and smooth; tergite IX free, divided and partly granulate. Anal plate with deep, broad sagittal groove and two lateral granulate protuberances; each inner wall of protuberances with scopula of curved setae.

Chelicerae: Basal segment granulate, with dorsal transverse ridge and four dorsal setae. Second segment smooth as in Forster (1955, fig. 4). Two types of teeth on inner surface of the movable finger (Fig. 4a). Second segment $2.7 \times$ length of movable finger.

Pedipalps (Fig. 4b): Trochanter with a strong ventral process (Fig. 4c); femur surface smooth; tarsus with claw and two subapical sensory solenidia.

Legs (Fig. 5): Legs I and II uniformly granulate with secondary ornamentation (small thorns between the granulations), except tarsi which are wholly smooth and metatarsi which have granulations and ornamentation confined to dorsal and dorsolateral sides of the proximal part. Dorsal side of metatarsi with two successive different curvatures. All segments of legs III and IV granulate except the tarsi.

Tarsus I differs from the others by its shape; it is enlarged and has a ventral brush of short, close-set, wiry hairs distally. Tarsi of legs I and II with dorsal solenidia (respectively 8 and 10) and a subapical sensory process. All segments with long bristles (sensilla chaetica); metatarsi and tarsi of

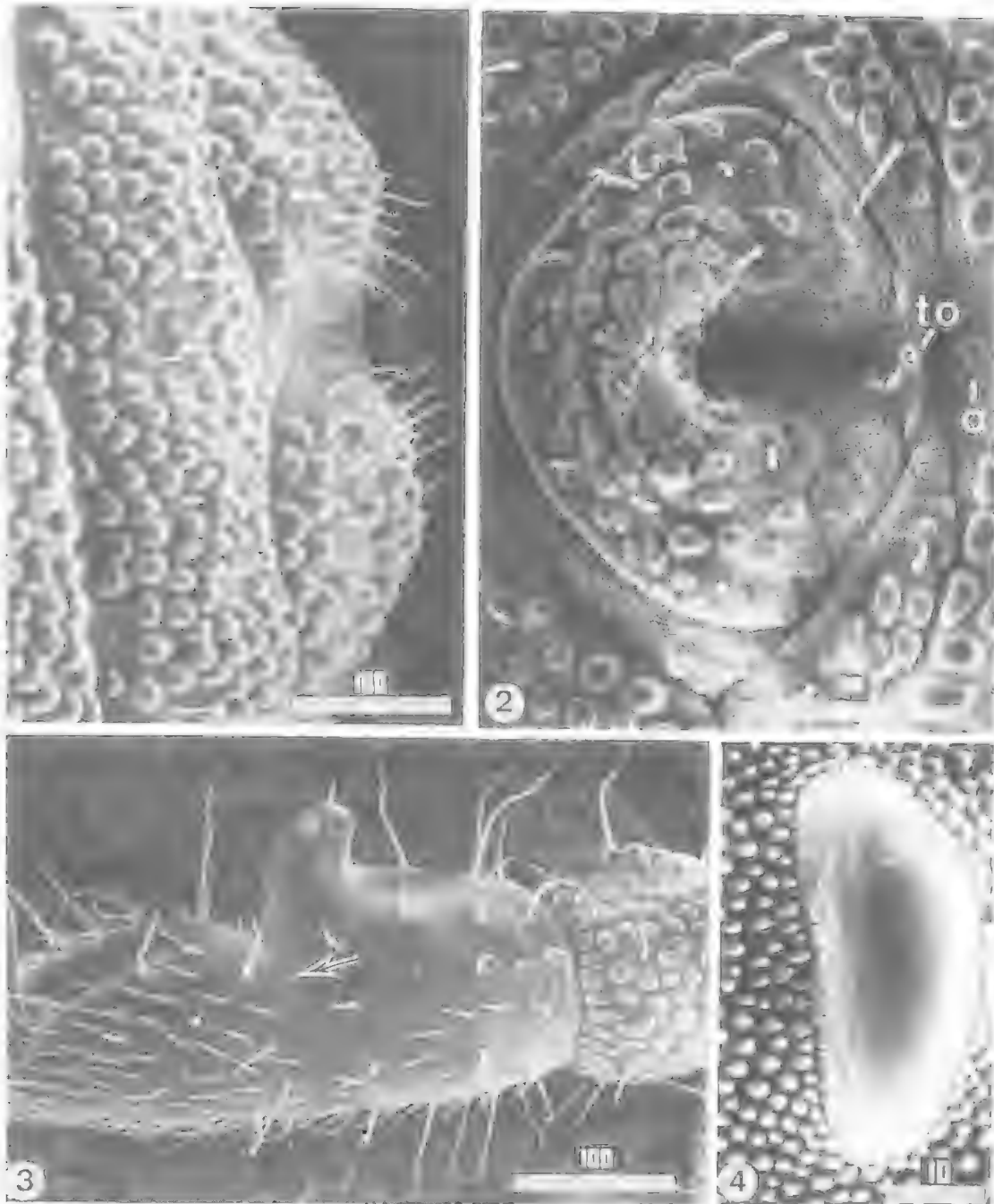


FIG. 2. ♂ *Rakaia daviesae* sp. nov. 1. Body, posterior part, dorsal view; 2. corona analis; 3, tarsus smooth and metatarsus IV granulate; 4. a granulation on the prosoma (first level of ornament) and small thorns (second level of ornament). o = opening of the anal gland; to = twin openings; arrow = transverse groove limited to dorsal side.

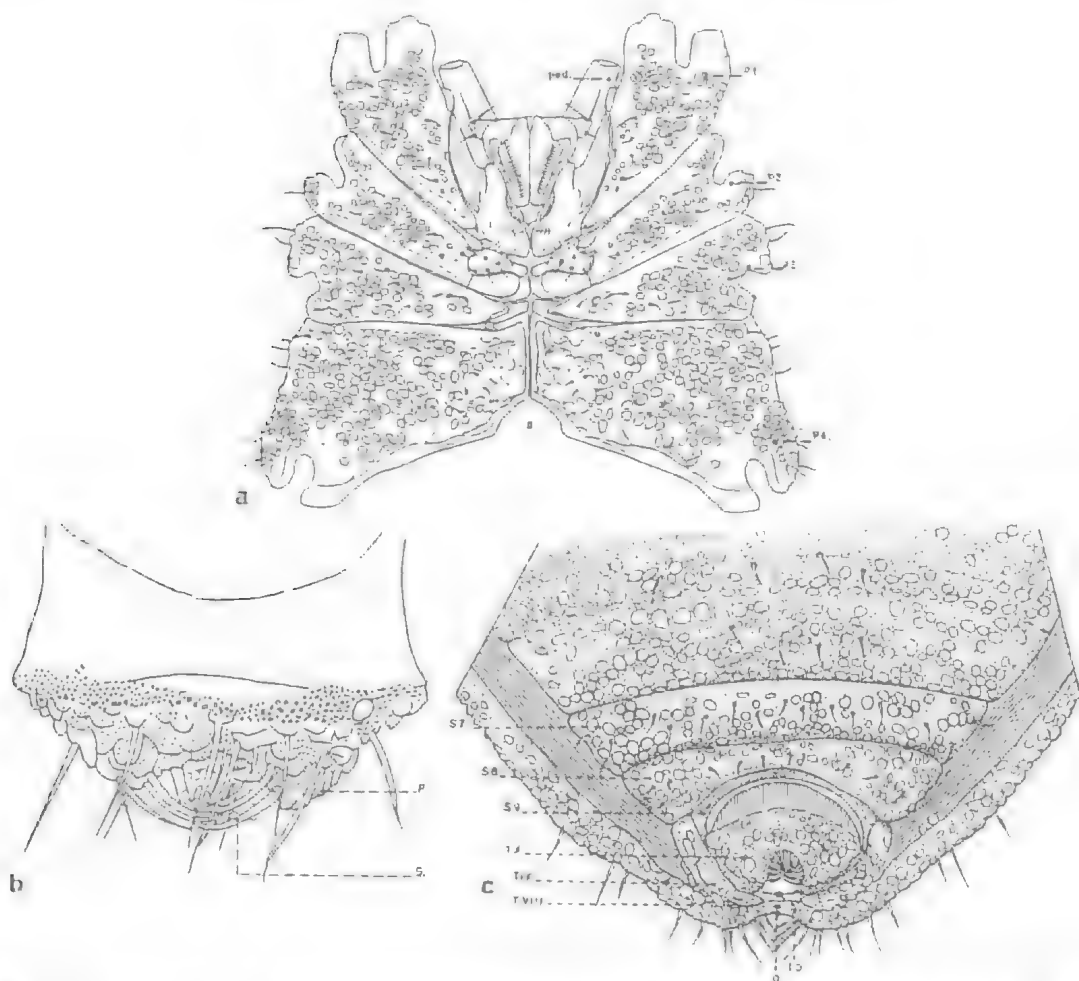


FIG. 3. *?*, ventral. a. p. 1-4, Coxae. b. Anal plate in anterior view. c. Posterior part of the body and corona analis. g = genital aperture; P = protuberance; S = sternite; T = tergite; o = opening of anal glands; to = twin openings.

legs I and II with numerous false-hairs, so-called chetoids. Tarsal claws smooth, asymmetrical in dorsal view, and with a low plate on the posterior side.

A puzzling feature which has not been investigated histologically is a narrow elongate area near the apex of the claw of leg II; it appears to join a canal running within the claw and/or to be connected to a gland in the apical part of the tarsus (Fig. 6a). However, no opening was seen with scanning electron microscope. A median groove on dorsal side of tarsi above claws may serve to receive claw. However, groove seems not so deep as in *Pettalus cimiformis*, *Ogovea grossa* and *Metagovea gabonica* where claws are surely retractile.

Tarsus IV and adenostyle (Figs 2, 5d, 6b). Tarsus IV is a single segment but semi-divided dorsally, seen clearly on scanning electron photograph (see arrow). Dorsal spur erected, subconical, with anterior margin much longer than posterior and provided with a translucent thorn inserted near apex on prolateral side. Opening of tarsal gland is near apex on posterior side. Adenostyle very similar to that of *Rakaia woodwardi* (see Forster, 1955, fig. 3) except that the long hair is inserted lower.

Penis (Fig. 7a, b): Very short with dorsal surface shorter than ventral. Apex of dorsal surface with a single, V-shaped series of long setae, 8 on the left and 9 on the right (a single penis examined); ventral surface with two long setae. From the

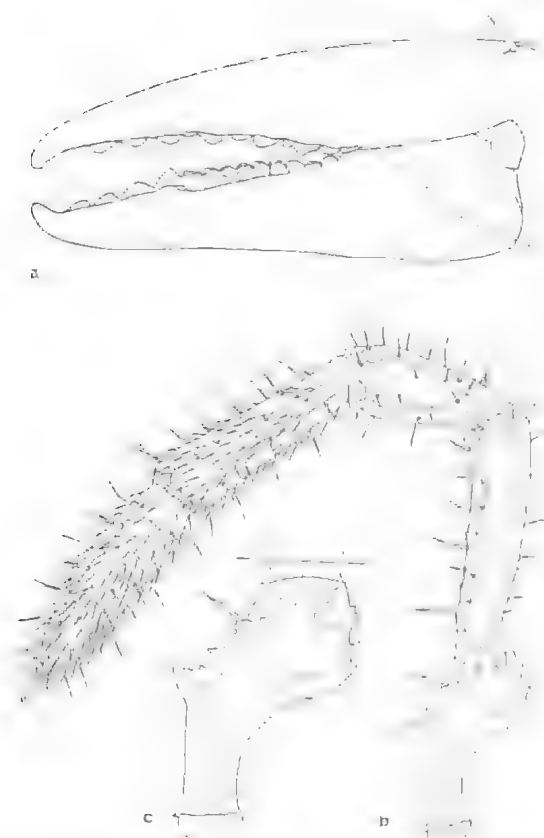


FIG. 4. *J.* a. Fingers of chelicerae. b. Pedipalp. c. Trochanter of pedipalp.

dorsal to the ventral side, the elements of the apical part of the penis are: 2 movable semicircular fingers with thin horns on these bases, inserted each side of gonopore; 1 short, trapezoidal, flat and smooth membranous lobe; 1 apical lobe, smooth, with 6 setae (3 on the left, 3 on the right) shorter than the dorsal setae.

DESCRIPTION OF FEMALE

It is like the male except that the posterior margin of abdomen is rounded; tergite IX entire and curved behind anal operculum which lacks scopula, granulate protuberances and median groove; tarsus IV without dorsal spur and not semi-divided.

Ovipositor (Fig. 7d): Long, with 26 joints and 2 terminal lobes. Each joint with 4 dorsal bristles and 4 ventral (sensilla chaetica); these bristles are short from joint 1 to 24, long on joints 25 and 26, 3 times as long as those on 24. Terminal lobes elongate, with normal bristles and 2 bristles as long as those of the last joint; each lobe with a subapical, lateral, 7-branched sensory process.

DISCUSSION

Forster (1955) distinguished *Neopurcellia* from *Rakaia* by a single character: tarsus IV of the male 2-segmented in former and 1-segmented in the latter. However, *R. daviesae* is intermediate and has the dorsal side of the single segment of tarsus IV of the male divided. The scanning electron photograph confirmed this feature which was not easy to interpret with the light microscope.

This suggests that perhaps *Neopurcellia* should be synonymized with *Rakaia* or a new genus described for *R. daviesae*. Since many characters of *R. daviesae* are similar to those of *R. woodwardi* (adenosyle, corona analis, leg I), I decided to include the new species in *Rakaia* and to retain *Rakaia* and *Neopurcellia* as valid genera.

In *R. woodwardi* and *R. daviesae*, the trochanter of pedipalp has a strong ventral process in common with many New Zealand species of *Rakaia* (*R. antipodiana*, *magna*, *dorothea*, *media*, *solitaria*, *pauli*, *sorenseni*, *isolata* and *uniloca*). The rest of the described species lack the trochanteral process on the 3 palp. The significance of this feature in *Rakaia* is not clear; either it represents two phyletic series, or the trochanteral process is not a significant character.

PETTALIDAE AND SIRONIDAE

Shear (1980) suggested a new and probably more accurate classification of the Cyphophthalmi, recognizing five families: Stylocellidae Hansen and Soerensen; Ogoveidae Shear; Neogoveidae Shear; Sironidae Simon; and Pettalidae Shear. He included all the austral Gondwana genera, except *Troglosiro*, in the new family Pettalidae. These were from Chile (*Chileogovea*, revised by Juberthie and Muñoz-Cuevas, 1970), South Africa (*Purcellia*, *Parapurcellia*), Sri Lanka (*Pettalus*), Australia and New Zealand (*Rakaia*, *Neopurcellia*). Pettalidae is closely related to Sironidae and the most significant morphological character distinguishing the two families is the number of kinds of cheliceral teeth: one in Sironidae and two in Pettalidae. Another character is less significant: the position of odoriferous gland tubercles (ozophores) which are types 1 and 2 in Sironidae, and type 2 or 3 in Pettalidae. Shear (1985) wrote of his new classification 'the diagnoses of these families were satisfying unequivocal . . . At that time, only a single cyphophthalmid species defied easy placement in my scheme: *Troglosiro* . . . Now a second species has come to light [*Marwe coarcta* Shear, 1985, from Kenya] so that its position is difficult to assess'.

The position of *Parapurcellia* is uncertain,

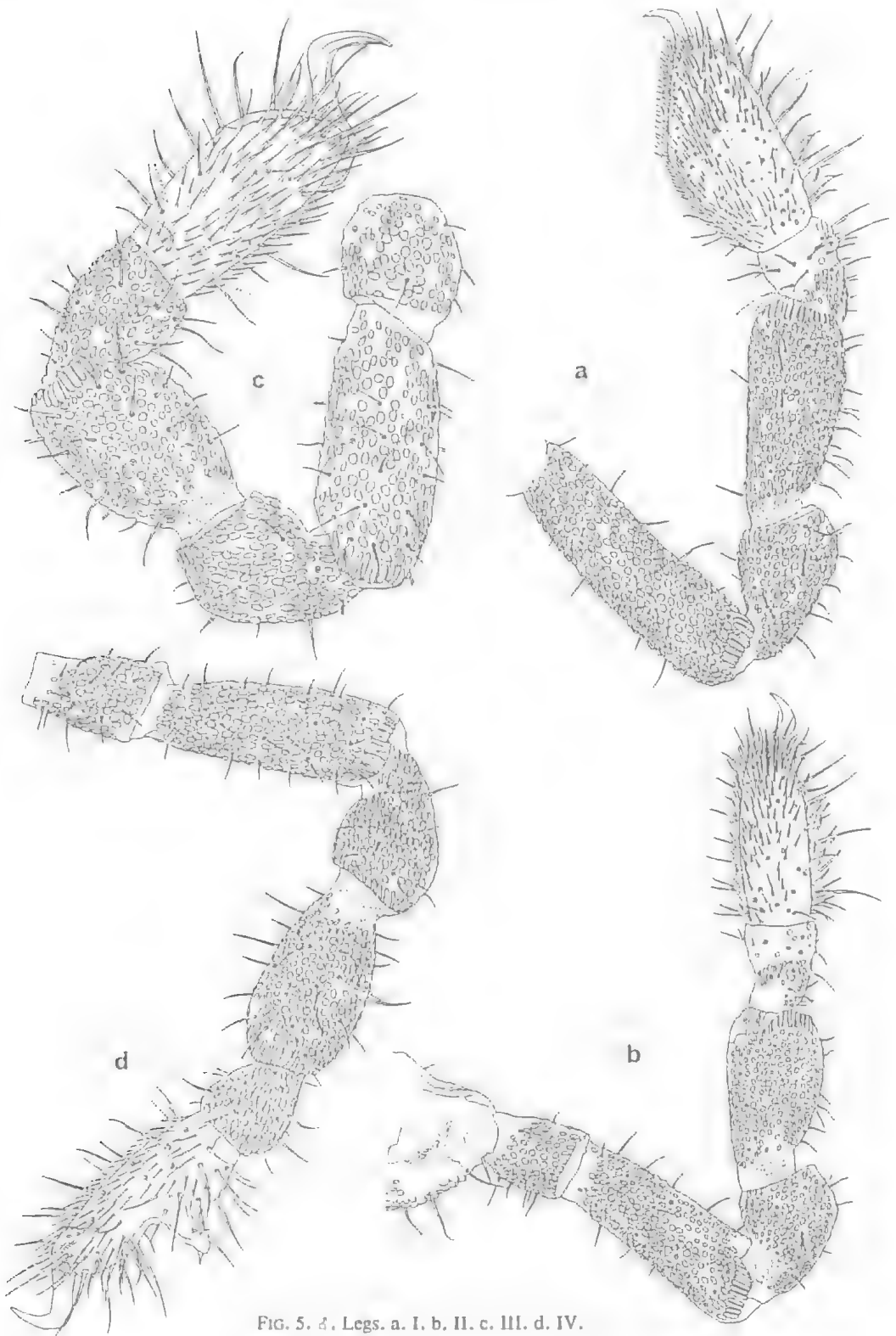


FIG. 5. ♂, Legs. a. I. b. II. c. III. d. IV.

Adding to the brief description by Lawrence (1933, 1939), Juberthie (1970, figs 7a,b) found that δ *P. rumpiana* did not have the main characters of Pettalidae. As in Sironidae it has only one kind of cheliceral teeth and type 2 ozophores, that is, the ozophores (odoriferous tubercles) are set at a distance equal to their diameter from the lateral margin and 'project distinctly beyond the lateral margin of the carapace'. Further, according to Lawrence (1933) and Rosas Costa (1950), δ *P. rumpiana* differs from the δ in having type 3 ozophores as in Pettalidae. Lawrence (1963) agreed with Rosas-Costa in regarding the position of the odoriferous tubercles as of secondary importance, having no generic value. *Parapurcellia* is the only genus showing sexual dimorphism in the position of the odoriferous tubercles; in all other genera their position is a good character.

Two features of the anal region were also used by Shear (1980) to separate the two families. First, sternites and tergites of corona analis free (Pettalidae), partially or entirely fused (Sironidae). Secondly, anal region slightly modified, involving

midline crest or groove in anal plate (Sironidae) and 'anal region strongly modified, modifications taking form of deep groove on anal plate, ninth tergite (which may be divided) and eighth tergite (which may be strongly bilobed), these grooves often with tufts of setae' (Pettalidae).

The first character is common to all species of Pettalidae except *Pettalus brevicauda* (in Juberthie, 1979) and *Pettalus cimiformis* (in Hansen and Soerensen 1904, plate III, fig. 2g), which have sternites 8 and 9 fused in the midline. For the second character, no Sironidae have a tuft of setae in anal region; in contrast numerous Pettalidae have setae within the groove of the anal operculum, and/or tergite VIII or on the internal side of the bilobate protuberances of tergite VIII; however a few species of *Rakaia* (*R. tumidata*, *calcarobtusa*, *granulosa*) and *Chileogovea oedipus* have a scopula in this region. The presence of tufts of setae in the groove of the anal operculum in *Parapurcellia rumpiana*, *P. silvicola* and *P. fissa*, and a scopula on the dorsal surface of anal plate in *Parapurcellia monticola*, similar to *Rakaia pauli*, *sorenseni*, *media*, *sollitaria*, etc., is a feature which suggests the inclusion of *Parapurcellia* in Pettalidae.

Other characters are probably also important, but have not been described in all genera and species: (1) Tarsus I with a well developed ventral brush in the proximal half: *Pettalus cimiformis* and *brevicauda*, *Rakaia woodwardi*, *R. daviesae*, *Neopurcellia salmoni* and *Neopurcellia* n.sp. from Australia, *Chileogovea oedipus*, *Speleosiro argasiformis*, *Purcellia illustrans*. This brush seems more developed than in species of Sironidae from Europe and America for which descriptions are available; (2) Retractable claws. Authors have drawn little attention to this feature, which is not easy to observe. Several species and genera in Pettalidae have a deep dorso-apical and median groove to receive their claws: *Pettalus cimiformis* (Leg IV in Hansen and Soerensen, 1904), *Purcellia illustrans* (Legs III and IV examined by Juberthie, 1970), *Rakaia daviesae*, *Neopurcellia* n.sp. from Australia (Legs III, IV examined). It is premature to weight this character without examination of all genera of the Sironidae.

CONCLUSION

The Pettalidae, limited to *Chileogovea*, *Pettalus*, *Purcellia*, *Rakaia*, *Austropurcellia* and *Neopurcellia*, is a homogeneous family separated from Sironidae by the presence of two kinds of teeth on the movable finger of chelicerae.

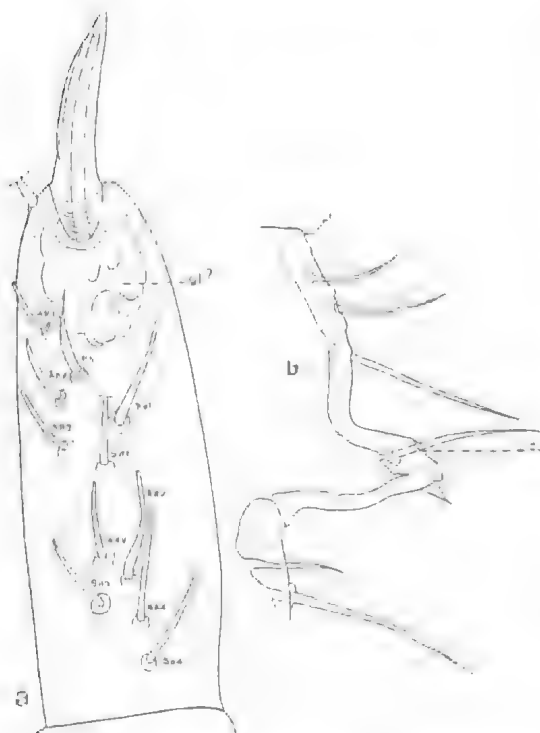


FIG. 6. δ . a. Tarsus II, dorsal view. b. Adenostyle of tarsus IV. PS = sensory process; Sa, Sd, Sp = Solenidia on anterior, dorsal, posterior side; o = opening of the tarsal gland; gl = hypothetical gland.

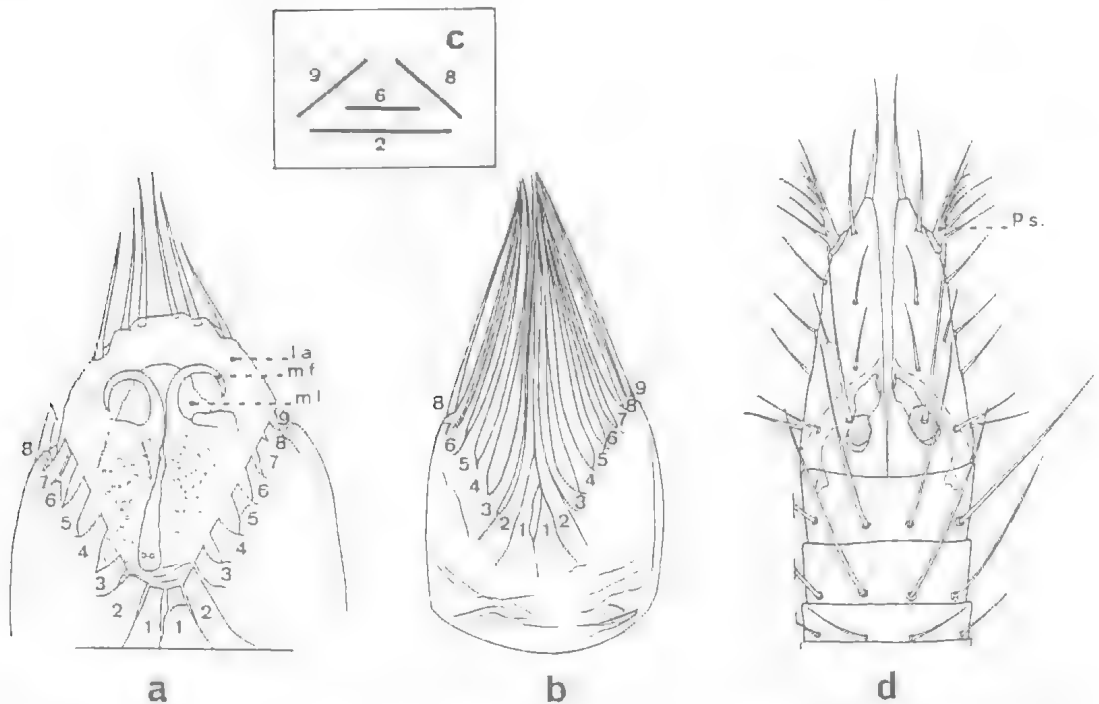


FIG. 7. a, b. Penis, ventral and dorsal view. c. Diagram of the setae of the penis. d. Ovipositor, apical part. Ps = sensory process; la. = apical lobe; mf = movable finger; ml = membranous lobe.

However, several other African and New Caledonian species (*Parapurcellia*, *Marwe*, *Troglosiro*) show not only the main character of Sironidae (one type of teeth), but also some characters of Pettalidae or peculiar features, so that the clade, Sironidae-Pettalidae, is probably a limited view of a more complex phylogeny.

All data suggest that the geographical distribution of cyphophthalmids (Juberthie and Massoud, 1976) is earlier than the breakup of Gondwanaland, 150 million years ago; these Opiliones were widespread before this event. At the present time, the majority of the cyphophthalmids probably represent relict species with a very low rate of evolution. For example, very small morphological differences have arisen between the populations of *Parasiro coiffaiti* in the French Pyrenees and *Parasiro minor* in Corsica, since the separation 20–25 million years ago of the European landmass and the Corsica-Sardinia crustal plate. The phylogeny is particularly difficult to determine as no fossils are known.

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THE AUSTRALIAN ANTS OF THE *POLYRHACHIS RELUCENS* SPECIES-GROUP (HYMENOPTERA: FORMICIDAE: FORMICINAE)

RUDOLF J. KOHOUT

Kohout, R.J. 1989 11 13: The Australian ants of the *Polyrhachis relucens* species-group (Hymenoptera: Formicidae: Formicinae), *Mem. Qd Mus.* 27(2): 509-516. Brisbane, ISSN 0079-8835.

The Australian ants of the *Polyrhachis relucens* species-group, traditionally placed in the subgenus *Myrma* Billberg, are reviewed. Four species are recorded, including *Polyrhachis andromache* Roger, 1863, and *Polyrhachis rufofemorata* Fr.Smith, 1859, and two, *P. inusitata* and *P. foreli*, which are described as new. A key to species is provided, and all are illustrated. Notes on distribution and nesting habits are included.

□ *Formicidae, Polyrhachis, relucens-group, Australia, systematics.*

Rudolf J. Kohout, Queensland Museum, PO Box 300, South Brisbane, Queensland 4101, Australia; 26 August, 1988.

Four species of the *Polyrhachis relucens* species-group are recorded from Australia, two of which are described as new. The ants of this group are traditionally assigned to the subgenus *Myrma* Billberg and can be characterised by the following combination of characters:

1. Dorsum of mesosoma convex in profile; lateral margins distinct, with margination interrupted only at the sutures.
2. Pronotum armed with a pair of relatively long, straight, more or less anteriorly-directed spines.
3. Propodeum either unarmed or with tubercles or small teeth.
4. Promesonotal suture and propodeal groove distinct.
5. Petiole scale-like, usually armed with a pair of dorsal spines or denticles, each with a laterally oriented tooth or blunt angle below its base.
6. First gastral tergite basally truncated or shallowly concave.
7. Anterior clypeal margin arcuate, often bluntly truncated medially.
8. Mandibles at their bases finely longitudinally striate.
9. Frontal carinae forming sharply raised, lamellate flanges; the area between them relatively narrow.

The illustrations were prepared using a Zeiss (Oberkochen) SR Stereomicroscope and camera lucida. All depict the primary types, except those of the geographically variable *P. rufofemorata* Fr.Smith, where a typical Australian specimen, characterised by gracile stature and spinose petiole, is illustrated. The measurements (in mm) and indices are those of Kohout (1988a). The abbreviations for institutions and depositories are as used by Taylor and Brown (1985) and Kohout (1988a). Some distribution records are cited using

1-degree coordinates, following Taylor (1987). Most of the specimens studied are lodged in the ANIC, QM and RJK collections.

Polyrhachis andromache Roger, 1863 (Figs 1, 1a, 6, 10)

Polyrhachis hector Fr.Smith, 1859:142. Holotype worker. INDONESIA: Aru I.(A.R.Wallace), OUM (Examined). Nom. preocc. Junior homonym of *Polyrhachis hector* Fr.Smith, 1857.

Polyrhachis andromache Roger, 1863:8, 46. Replacement name.

Full reference citations with synonymy are given by Kohout (1988b) and are not repeated here.

DIMENSIONS OF HOLOTYPE

TL 8.82; HL 2.32; HW 1.81; CI 78; SL 2.82; SI 156; PW 1.21; MTL 2.82.

ADDITIONAL MATERIAL EXAMINED

NEW GUINEA: Ighibirei, vii-viii 1890, L.Loria. PAPUA NEW GUINEA: Eastern Highlands Prov., Kratke Ra., Mt Piora, 12 June 1966, O.R. Wilkies. Northern Prov., Popondetta, 15 i 1971, B.B.Lowery; Oro Bay, 30mi S of Popondetta, 14 i 1971, B.B.Lowery. Western Prov., Middle Morehead Riv., 08.50 S x 141.30 E, August 1967, R.Pullen. AUSTRALIA: Queensland, Torres Strait, Badu I., 18 ii 1984, J.H.Sedlacek. Cape York Penins., Bamaga, 21 i-12 ii 1984, J.H.Sedlacek; 10.53 S x 142.23 E, 18-24 March 1987, RJK acc. 87.5. Lockerbie Scrub, January 1975, G.B.Monteith; xii 1983, J.H.Sedlacek; 9-11 xii 1986, J.Gallon; 10.46 S x 142.29 E, 19-23 March 1987, RJK acc. 87.19, 25, 49, 59, 73. Iron Range, 1-3 vii 1976, P.Filewood; 1-17 vii 1978, S.van Dyck; 12.43 S x 143.18 E, 26-31 July 1981, RJK acc. 81.130, 166, 194, 197, 214, 215; 17 iii 1984, J.Sedlacek. West Claudie Riv., 3-10 xii 1985, G.B.Monteith and D.Cook; East Claudie Riv., 6 xii 1985, G.B.Monteith and D.Cook.

WORKER

Dimensions: TL 7.58-9.73; HL 2.12-2.50; HW 1.65-2.01; CI 78-82; SL 2.56-2.97; SI 145-158; PW 1.18-1.51; MTL 2.59-3.07 (30 measured).

Mandibles with 5 teeth. Clypeus in profile almost straight; the anterior margin entire. Sides of head in front of eyes shallowly concave, slightly converging anteriorly; widely rounded behind. Eyes convex, in full face view usually only marginally breaking the outline of the head. Frontal carinae sharply raised. Pronotal dorsum with a pair of long, divergent, somewhat flattened spines; their dorsolateral borders continuous with the pronotal margins. Mesonotal dorsum transversely convex, wider than pronotum at the base, the lateral margins converging strongly posteriorly. Propodeal dorsum almost flat, with margins converging into weakly upturned posterior angles. Petiole with two posterodorsally directed spines and, between them, a more or less distinct, small intercalary tooth. A somewhat flattened, deeply emarginated tooth, is situated laterally below the level of the base of each spine. First gastral tergite shallowly concave basally.

Mandibles finely, regularly striate, with numerous piliferous pits. Head and lateral branches of mesosoma finely reticulate; dorsum of mesosoma, petiole and the gaster shagreened.

A few long, erect, somewhat undulated hairs scattered on dorsum of the head and mesosoma. Such hairs are relatively more abundant and posteriorly directed on the gaster. Bright golden or, less frequently, silvery pubescence more or less obscuring the underlying sculpturation, and abundant all over the body, except on the mandibles and tips of the spines.

Generally black, with coxae, femora, tibia and proximal and distal ends of the antennal scapes yellow or light yellowish-brown.

FEMALE

Dimensions: TL 9.98-11.59; HL 2.50-2.74; HW 2.01-2.21; CI 79-82; SL 2.87-3.12; SI 136-143; PW 2.03-2.22; MTL 3.06-3.22 (7 measured).

Female almost identical to worker apart from its larger size and the characters identifying full sexuality. The pronotal spines are shorter and downturned, and the dorsum of petiole armed with 3 distinct teeth (Fig. 1a).

Males and immature stages are present in the ANIC and RJK spirit collections.

REMARKS

Colonies of *P. andromache* usually nest in tree or other plant cavities (as in hollow internodes of

a standing dead bamboo *Bambusa forbesii* at Iron Range), but occasionally build pocket-like nests of silk and debris against tree trunks (Kohout, 1988b). The known distribution is from Moluccas to New Guinea and northern Australia, where the species has been recorded from Torres Strait Islands and Cape York Peninsula as far south as Iron Range (Grid cells 6/145, 8/141, 9/142, 10/142, 10/143, 12/143).

***Polyrhachis foreli* sp. nov.**

(Figs 2, 2a, 7, 11)

Polyrhachis (Myrma) relucens r. *andromache* var. *andromeda* Forel, 1915:110. Syntype workers. AUSTRALIA: Queensland, Bellenden Ker (E. Mjöberg) NHRM, GMNH, ANIC (Examined). (An inadmissible infrasubspecific name).

MATERIAL EXAMINED

HOLOTYPE: AUSTRALIA: Queensland, NE. Tully, nr Clump Point, 17.52 S x 146.07 E (type locality), 30 April 1969, ex rotting wood piece, R.W. Taylor acc. 69.123 (worker).

PARATYPES: data as for holotype (5 nidoparatype workers, 1 nidoparatype dealate female, 3 nidoparatype alate females, 4 nidoparatype males and immature stages - larvae and pupae of 2 males and 1 female); c. 6 km W of South Mission Beach, 17.56 S x 146.02 E, 18-19 July 1980, RJK acc. 80.60 (19 paratype workers).

TYPE DEPOSITION

Holotype (Type no. 7734), 3 nidoparatype workers, 2 nidoparatype females (1 dealate, 1 alate), 4 nidoparatype males and 2 paratype workers in ANIC; 2 nidoparatypes (1 worker, 1 alate female) and 2 paratype workers in QM; 2 nidoparatypes (1 worker, 1 alate female) in BMNH; 4 paratype workers in RJK; 1 paratype worker each in AM, BPBM, GMNH, MCG, MCZ, NHRM, NHMW, NMV, OUM, USNM, ZIK.

(Examined). Synonymy by Bolton (1974).

WORKER

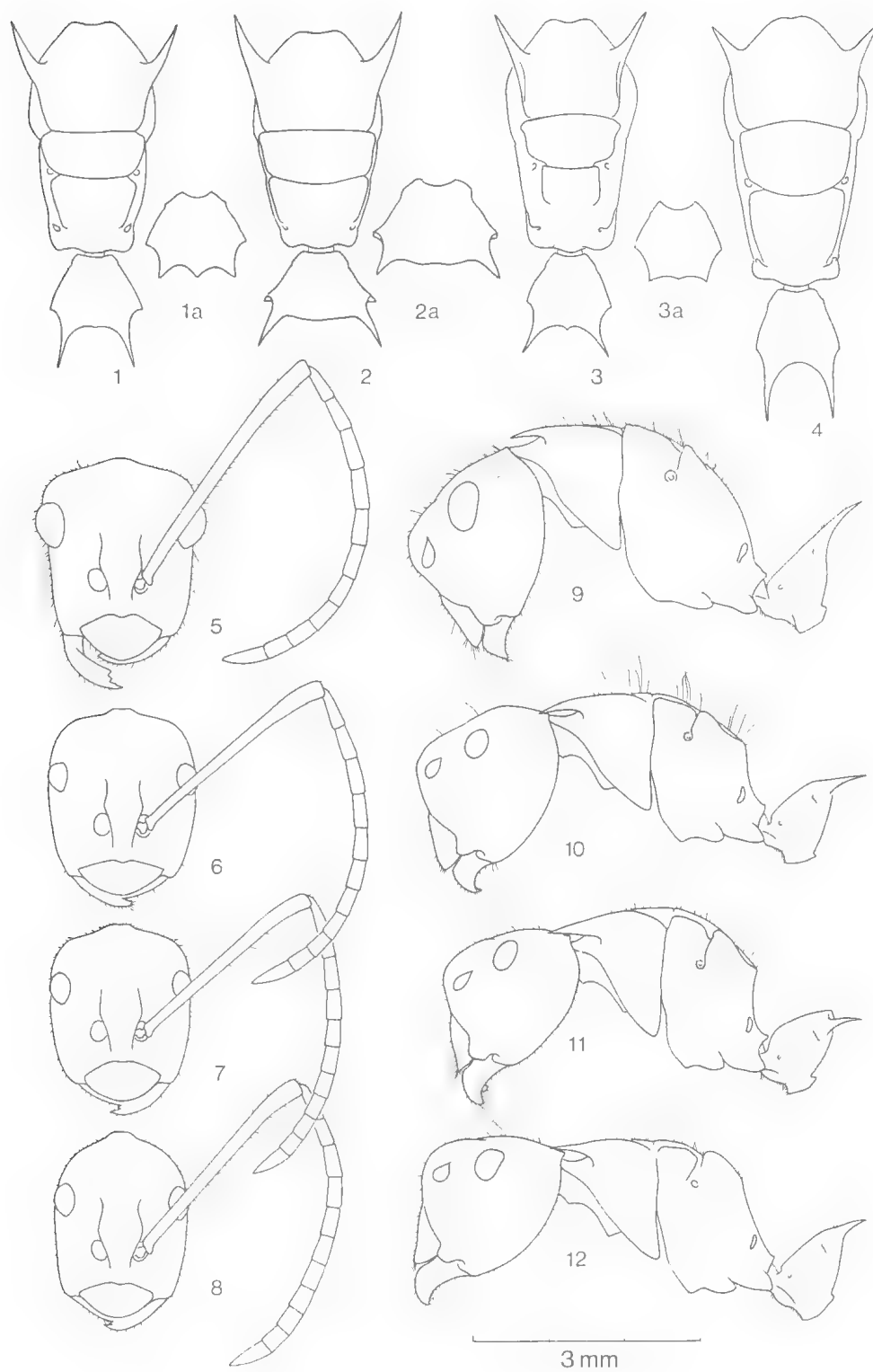
Dimensions (holotype cited first): TL 8.62, 8.16-9.37; HL 2.28, 2.21-2.46; HW 1.87, 1.75-1.96; CI 82, 78-82; SL 2.71, 2.59-2.90; SI 145, 145-153; PW 1.59, 1.50-1.75; MTL 2.84, 2.71-3.06 (25 measured).

FIGS 1-4. Dorsal view of mesosoma and anterior view of petiole (pilosity omitted): 1, *P. andromache*; 2, *foreli*; 3, *rufofemorata*; 4, *inusitata*.

FIGS 1a-3a. Anterior view of petiole (females): 1a, *P. andromache*; 2a, *foreli*; 3a, *rufofemorata*.

FIGS 5-8. Head in full face view (right antennae omitted): 5, *P. inusitata*; 6, *andromache*; 7, *foreli*; 8, *rufofemorata*.

FIGS 9-12. Lateral view (antennae, legs and gaster omitted): 9, *P. inusitata*; 10, *andromache*; 11, *foreli*; 12, *rufofemorata*.



ADDITIONAL MATERIAL EXAMINED

AUSTRALIA: Queensland, Cape York Penins., Iron Ra., 1-3 July 1976, P. Filewood; 12.43 S x 143.18 E, 26-31 July 1981, RJK acc. 81.182. West Claudie R., 3-10 xii 1985, G.B. Monteith and D. Cook, Cooktown, Staudinger et Bang-Hass. Home Rule Stn., 32km S of Cooktown, Oct-Nov 1974, T.P. Tebble. Shipton's Flat, 35km S of Cooktown, 22 April 1982, G.B. Monteith. Mt Finnigan, 37km S of Cooktown, 19-21 April 1982, G.B. Monteith. Gap Creek, Twelve-mile Scrub, 15.50S x 145.19E, V. Davies and R. Monroe, Helenvale, 10-20 July 1976, P. Filewood. Cape Tribulation, 29 xii-8 i 1983, G.B. Monteith; 16.04S x 145.27E, 6 xii 1985, RJK acc. 85.3. Yarrabah, c. 9km E of Cairns, 16.54S x 145.51E, 22, 24 July 1980, RJK acc. 80.119. N Bell Peak, 20km S of Cairns, 16 Sept 1981, G.B. Monteith and D. Cook. Bellenden Ker Landing, Russell R., 1-9 Nov 1981, Qd Museum/Earthwatch Exp.; ditto, 4 viii 1975, B.B. Lowery. Babinda, 1920, J.F. Illingworth. Hinchinbrook I., Gayundah Ck, c. 10m, 8-18 Nov 1984, G.B. Monteith.

WORKER

Dimensions: TL 7.36-10.33; HL 1.96-2.46; HW 1.59-2.00; CI 78-82; SL 2.40-2.91; SI 145-153; PW 1.31-1.78; MTL 2.31-3.12 (25 measured).

Mandibles with 5 teeth, which reduce progressively in length towards the base. Clypeus in profile sinuate, convex above, shallowly concave below, the anterior margin somewhat obtusely truncated medially. Sides of head gently convex, converging anteriorly in front of eyes, and narrowly rounded behind the eyes into the weakly convex occipital margin. Eyes convex, situated well back on the head, usually not or only marginally breaking the cephalic outline. Frontal carinae with strongly raised lobes; area between them more than twice as wide behind than in the front. Pronotum with dorsum almost flat between a pair of long, horizontal, anteriorly directed, somewhat dorso-medially flattened spines. Outer borders of spines acute and continuous basally with the pronotal margins. Mesonotal dorsum wider than pronotum at the base, strongly transverse; lateral margins slightly raised, acute. Propodeum with narrowly rounded anterior angles, its sides converging posteriorly, terminating in more or less distinct, short, transverse tubercles, which are sometimes produced into small, posteriorly directed teeth. Declivity abrupt, concave in profile. Petiole in side view biconvex, armed with a pair of spines situated on the dorsolateral angles and separated by the transversely convex, more or less acute dorsal edge of the segment. A short, somewhat flattened, emarginated tooth on each side, situated laterally below the base of the adjoined spine. Base of first gastral tergite shallowly concave.

Mandibles towards the base finely, longitudi-

nally striate, with numerous piliferous pits. Clypeus finely shagreened; anterior margin medially with a few distinct pits from which long hairs rise. Front of head shagreened; sculptural intensity more distinct laterally and posteriorly, with the dorsal face and lateral branches of occiput more or less longitudinally striate-punctate. Dorsum and sides of mesosoma fairly regularly longitudinally striate; sculptural intensity decreasing anteriorly and posteriorly, with the pronotal dorsum, spines, propodeal declivity, petiole and gaster shagreened.

Medium long, erect, silvery or golden hairs present in variable density on all body surfaces, but almost absent from the petiole and anterior face of the first gastral tergite. Leading edge of the antennal scapes occasionally with a few scattered short erect hairs. Relatively long, appressed, silvery to golden pubescence most dense on clypeus, frontal areas of head and the mesosomal dorsum.

Black throughout; only the appendages may sometimes be reddish-brown.

FEMALE

Dimensions: TL 10.23-11.44; HL 2.50-2.67; HW 1.96-2.14; CI 77-81; SL 2.87-3.06; SI 140-148; PW 2.21-2.37; MTL 3.06-3.22 (7 measured).

The female closely resembles the worker and, besides the usual characters identifying full sexuality, differs only in the following details: In full face view eyes clearly breaking the outline of head; pronotal spines much shorter, downturned; petiole with spines shorter, and the dorsal edge between them more or less medially emarginated (Fig. 2a).

Males and immature stages are present in the ANIC spirit collection.

REMARKS

The name-bearing specimens of the invalid infrasubspecific name, *Polyrhachis relucens andromache andromeda* Forel, 1915, are conspecific with the types of *P. foreli* (material from Forel collection has been examined). For reasons discussed by Taylor (1986), and following advice from Dr R.W. Taylor and Dr W.D.L. Ride, Chairman of the *International Commission on Zoological Nomenclature*, I have chosen not to use Forel's infrasubspecific epithet as the name for this species.

As well, the types of *P. foreli* are almost certainly closely related to the papuan name-bearing specimens of *Polyrhachis relucens decipiens papuana* Emery, 1897 (an another

invalid infrasubspecific name). Its workers and those of *foreli* are remarkably similar and share many features including the configuration of the petiolar spines. They might well be conspecific. However, examination of available queens of the two forms suggests that the queens are not conspecific. Females of *P. foreli* closely resemble their workers, while the only available putative female of the '*P. relucens decipiens papuana*' (from Emery's study series) shows significant differences. The petiolar spines, for example, are situated on the uppermost angles of the leading dorsal edge of the segment. Because of this, I doubt that the '*P. relucens decipiens papuana*' female is conspecific with the workers of Emery's series. The series thus appears to be composite and the workers and female might not have been collected together and actually represent two different species.

Colonies of *P. foreli* usually nest in old, partly rotten logs, but some were also found nesting in the ground, under stones (Taylor, pers.comm.). The known distribution ranges from Iron Range on Cape York Peninsula, south to Hinchinbrook Island (Grid cells 12/143, 15/145, 16/145, 17/145, 17/146, 18/146).

***Polyrhachis inusitata* sp. nov.**
(Figs 4, 5, 9)

MATERIAL EXAMINED

HOLOTYPE: AUSTRALIA: Queensland, Cape York Penins., West Claudie Riv., Iron Range area, 12.44 S x 143.14 E (type locality), 3-10 December 1985, G.B. Monteith and D. Cook (worker).

PARATYPES: data as for holotype (1 worker). Mellwraith Ra., Leo Creek Rd., 10-20 July 1976, P. Filewood (1 worker).

TYPE DEPOSITION

Holotype in QM (Type no. T.11122); 1 paratype each in ANIC and RJK.

WORKER

Dimensions (holotype cited first): TL 10.53, 9.38-9.82; HL 2.56, 2.31-2.37; HW 1.87, 1.72-1.75; CI 73, 74; SL 3.53, 3.30-3.48; SI 189, 192-199; PW 1.61, 1.36-1.51; MTL 3.56, 3.38-3.58 (3 measured).

Mandibles with 5 teeth. Clypeus almost straight in profile, anterior margin obtusely truncated medially. Head in front of eyes converging anteriorly; its lateral margins shallowly concave. Behind the eyes the head is markedly wider, with the sides forming a blunt continuous ridge

extending on each side toward the posterior angle, where it meets a similar ridge which commences on each side at the base of mandible and separates the gena from the ventral parts of the head. Eyes large, convex, situated well back giving the face a somewhat elongated appearance; in full face view the eyes clearly break the outline of the head. Frontal carinae with strongly raised lobes. Pronotal dorsum armed with a pair of relatively short, downturned, dorsally flattened spines; their lateral borders continuous with the posteriorly converging pronotal margins. Mesonotal dorsum narrower than pronotal, feebly transversely convex. Propodeum with anterior angles somewhat upturned, sides weakly margined and only slightly converging posteriorly, terminating in ill-defined angles. Petiolar dorsum armed with a pair of relatively long, slender, subparallel spines; the lateral teeth reduced to more or less distinct denticles. Base of first gastral tergite shallowly truncated.

Mandibles finely longitudinally striate, with numerous piliferous pits. Clypeus and front of head mostly finely irregularly rugose; sculptural intensity decreasing laterally, with sides of head finely reticulate, and increasing dorsally, with occiput more or less rugose. Dorsum and sides of mesosoma reticulate-punctate. Petiole and gaster finely shagreened.

Relatively short, semierect, yellowish to brown; hairs abundant on dorsum of head and mesosoma, and diluted elsewhere, particularly on the petiole, which has only a few very short hairs scattered along its lateral edge and on the spines. The hairs are relatively long on the gaster, where they are somewhat posteriorly directed. Very short, golden, appressed pubescence very dilute all over the body, except the gaster, where it is more abundant, with a distinct reddish tint on the dorsal aspect.

Black, with mandibles at the masticatory border and appendages infuscated reddish-brown.

Sexuals and immature stages unknown.

REMARKS

P. inusitata is closely allied to *P. continua* Emery from Papua New Guinea and shares with that species the curved outline of the mesosomal dorsum, the postocular and lateral ridges of the head and the slender petiole, with dorsum deeply concave between two, relatively long, erect spines. These species differ in the sculpturation of the head and body, which is irregularly reticulate-rugose in *inusitata*, while *continua* has the cephalic and mesosomal sculpturation regularly longitudinally striate. *P. inusitata* is also characterised by

having relatively short hairs abundant over most of the body, while in *continua* these hairs are distinctly longer and much diluted, with only a few breaking the outlines of the head and gaster. *P. inusitata* is markedly more slender than *P. continua*, which is a relatively robust, wider bodied species.

P. inusitata is apparently limited to the mid Cape York Peninsula, from the Claudie River basin at Iron Range to the McIlwraith Range (Grid cells 12/143, 13/143). It seems to be very rare and, in spite of intensive collecting within its distribution range, it has been taken only twice.

***Polyrhachis rufofemorata* Fr.Smith, 1859**
(Figs 3,3a,8,12)

Polyrhachis rufofemoratus Fr.Smith, 1859:142.
Holotype worker. INDONESIA: Aru I. (A.R.Wallace) OUM (Examined).

Polyrhachis merops Fr.Smith, 1860:98. Holotype worker. INDONESIA: Bachian I. (A.R.Wallace) OUM (Examined). Synonymy by Bolton (1974).

DIMENSIONS OF *P. RUFOFEMORATA*

Holotype: TL 8.55; HL 2.18; HW 1.61; CI 74; SL 2.59; SI 161; PW 1.09; MTL 2.90.

ADDITIONAL MATERIAL EXAMINED

INDONESIA: West Irian, Cyclops Mts, Ifar, 300-500m, 23-25 vi 1963, J.Sedlacek. PAPUA NEW GUINEA: West Sepik Prov., Oenake Ra., 10km WNW of Vanimo, 03.40S x 141.12E, 15 Aug 1984, RJK acc. 84.288. Torricelli Mts, Lumi, 400-550m, 03.28 S x 142.02 E, 4-13 Aug 1984, RJK acc. 84.283; October 1984, D.Waisi. Pes Mission, <50m, c. 12km WSW of Aitape, 03.11S x 142.15E, 31 July-3 August 1984, RJK acc. 84.154, 176. East Sepik Prov., Passam nr Wewak, 5 July 1972, R.W.Taylor. Morobe Prov., Busu Riv., nr Lae, 8 i 1968, B.B.Lowery; Bulolo, 12 xii 1967, B.B.Lowery; nr Wampit, c. 50m, c. 35km W of Lae, 06.45S x 146.40E, 24 & 27 Aug 1984, RJK acc. 84.347, 353, 365, 370, 373. Northern Prov., Popondetta, 14 i 1971, B.B. Lowery; Pongani R., c. 500m, Boikiki Plant., c. 8km NNE Afore, 09.06 S x 148.25 E, 29-30 Aug 1984, RJK acc. 84.386. Owen Stanley Ra., 500m, Mamba Plant., c. 7km WNW of Kokoda, 08.51S x 147.41E, 31 Aug-1 Sept 1984, RJK acc. 84.400, 403. Central Prov., Brown Riv., 22 i 1971, B.B.Lowery. AUSTRALIA: Queensland, Cape York Penins., Bamaga, 10.53S x 142.23E, 18 & 24 March 1987, RJK acc. 87.6. Iron Ra., 12.43S x 143.18E, 26-31 July 1981, RJK acc. 81.140, 191, 198, 211.

WORKER

Dimensions: TL 8.47-9.58; HL 2.27-2.53; HW 1.62-1.84; CI 71-77; SL 2.71-3.02; SI 154-170; PW 1.03-1.31; MTL 3.02-3.48 (35 measured).

Mandibles with 5 teeth. Clypeus sinuate in profile, convex above, concave below; median

carina more or less distinct; anterior margin truncated medially. Sides of head in front of eyes only feebly convex (almost straight in some specimens), slightly converging anteriorly; behind the eyes broadly convex. Eyes convex, in full face view not or only marginally breaking the outline of the head. Median ocellus weakly marked in some specimens. Frontal carinae sinuate with sharply raised lobes. Pronotum with a pair of long, divergent, somewhat flattened spines; their outer borders continuous, with posteriorly diverging lateral margins. Mesonotal dorsum wider than pronotum at the base, transversely convex, lateral margins acute but not laminate. Propodeal dorsum deeply concave between lateral margins, which form almost vertically raised lamellate flanges; posterior angles rounded, not acute. Petiole scale-like, with dorsal edge usually angulate or dentate, but also distinctly spinose, as in some New Guinean and all known Australian populations. Base of first gastral tergite very shallowly concave.

Mandibles finely longitudinally striate, with numerous piliferous pits. Anterior clypeal margin medially with a row of distinct pits from which long hairs arise. Sculpturation of the head and mesosoma consisting of fine to coarse reticulations, with dorsum of the head more or less longitudinally striate. Intensity of the sculpturation decreasing posteriorly, the petiole and gaster finely shagreened.

Short to medium long, semierect, yellow to rusty-brown hairs scattered all over the body. Short appressed pubescence of variable density everywhere, but almost absent from the petiole and the base of the first gastral tergite; colour of the pubescence yellow with distinct reddish tint on dorsum of head, mesosoma and gaster, more silvery on lateral and ventral surfaces of the body and appendages.

Body distinctly bicoloured; black, with the petiole, base of the first gastral tergite, coxae and femora, save for their apical portions, light to medium reddish-brown. Tips of the petiolar spines or denticles also black.

FEMALE

Dimensions: TL 9.42-10.43; HL 2.37-2.59; HW 1.68-1.89; CI 70-75; SL 2.77-3.02; SI 154-168; PW 1.61-1.91; MTL 3.17-3.53 (14 measured).

Female larger, with the usual characters identifying full sexuality. The sculpturation, pubescence and coloration is similar to that of the worker. Eyes convex, usually breaking the outline of the head. Configuration of the petiolar spines

variable, ranging from one to three, more or less acute teeth, situated along the dorsal edge of the segment between the distinct lateral angles (Fig. 3a).

Males and immature stages are present in the ANIC and RJK spirit collections.

REMARKS

As indicated above, *P. rufofemorata* occurs in two distinct forms, of which one has the petiole only angulate or dentate, while in the other it is distinctly spinose. This variability is occasionally accompanied by differences in other characters. For example, specimens with angulate petioles tend to be more stoutly built, while a distinctly spinose petiole is generally accompanied by more gracile stature. However, all these characters often integrate and no taxonomically significant variability seems to be present. Females of both forms are very similar and seemingly differ only in the length of the pronotal spines, which are somewhat shorter in females from colonies in which the workers have their petioles angulate.

This species is apparently lignicolous in nesting habits and most colonies were found in the hollow internodes of standing dead bamboo. The known distribution is from the Moluccas and New Guinea to Australia, where *rufofemorata* occurs on Cape York Peninsula from Bamaga south to Iron Range (Grid cells 2/140, 3/141, 3/142, 3/143, 6/146, 8/147, 9/148, 10/142, 12/143).

KEY TO AUSTRALIAN ANTS OF THE POLYRHACHIS RELUCENS SPECIES-GROUP BASED ON THE WORKER CASTE

1. Outline of mesosomal dorsum and declivity in side view forming a continuous curve (Fig. 9); antennal scapes relatively long (SI > 180) *P. inusitata*
Outline of mesosomal dorsum not forming a continuous curve - it consists of a clearly defined dorsum with the declivity more or less abrupt (Figs 10, 11, 12); antennal scapes relatively short (SI < 170) 2
2. Petiolar spines situated relatively close together, rising from the uppermost angles of the leading dorsal edge of the node (Figs 1, 3) 3
Petiolar spines widely separated, rising from the dorso-lateral angles of the node (Fig. 2) *P. foreli*
3. Propodeal dorsum concave; the lateral margins

forming almost vertically raised lamellate flanges; antennal scapes with numerous short erect hairs (Fig. 8)

..... *P. rufofemorata*

Propodeal dorsum more or less flat; the lateral margins distinct, but not lamellate; antennal scapes without erect hairs (Fig. 6)

..... *P. andromache*

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THE FAMILY HEXACROBYLIDAE SEELIGER, 1906 (ASCIDIACEA, TUNICATA)

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Kott, P. 1989 11 13: The family Hexacroblyidae Seeliger, 1906 (Ascidiacea, Tunicata). *Mem. Qd Mus.* 27(2): 517–534. Brisbane. ISSN 0079–8835.

Hexacroblyidae, a family containing seven highly adapted abyssal ascidian species in two genera, is closely related to the Molgulidae. A review of the literature together with examination of 14 newly recorded and some previously recorded specimens including the type of *Hexacroblyus psammatodes* Sluiter, 1905 (the type species of the genus *Hexacroblyus*) shows that the latter species is not congeneric with *Hexacroblyus indicus* Oka, 1913. *Hexacroblyus* Sluiter, 1905, *Gasterascidia* Monniot and Monniot, 1968 and *Sorbera* Monniot and Monniot, 1974 are treated as synonyms of *Oligotrema* Bourne, 1903. A new genus is erected to accommodate *Hexacroblyus indicus* Oka, 1913.

□ Ascidiacea, Molgulidae, *Hexacroblyus*, *Oligotrema*, *Gasterascidia*, *Sorbera*, *Asajirus*, abyssal.

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The family Hexacroblyidae Seeliger, 1906 was erected to accommodate its type species *Hexacroblyus psammatodes* Sluiter, 1905 from the Java Sea. Oka (1913) described a further species, *Hexacroblyus indicus*, from the Indian Ocean near Sri Lanka, noting its similarity to *Oligotrema psammites* Bourne, 1903 from New Britain; and confirming the close affinity of both species with the family Molgulidae — a similarity that both Sluiter and Bourne also had noted. Huus (1936) included these three species, *Hexacroblyus psammatodes*, *H. indicus* and *Oligotrema psammites*, together with *Hexacroblyus arcticus* Hartmeyer, 1923, in the family Hexacroblyidae.

Owing to incomplete diagnoses that have resulted from problems in the interpretation of contracted and often mutilated specimens with novel adaptations, there has been confusion in the taxonomy of members of the family.

In this work the comparison of 14 newly recorded specimens with others previously recorded, and with published descriptions has clarified the phylogeny of the family and the relationships of its species.

The specimens marked with an asterisk in the Distribution section of each species treated have been examined in the course of this study. The following abbreviations have been used preceding museum registration numbers: USNM American National Museum of Natural History, Smithsonian Institution, Washington D.C., USA; AM Australian Museum, Sydney, Australia; AMNH American Museum of Natural History, New York, USA; MV Museum of Victoria, Melbourne, Australia; ZMA Zoological Museum, University of Amsterdam, The Netherlands.

EXAMINATION OF SPECIMENS

Owing to the reduction of the branchial sac, it is not possible to dissect individuals of this family by opening them along the endostyle as in most stolidobranch and phlebobranch ascidians. Small individuals, gently removed from the test, can be examined whole by staining in alcohol soluble stain and clearing in glycerol. If dissection is necessary, most organs can be displayed by opening the left atrial cavity to the left of the mid-dorsal line, and then opening the buccal cavity and pharynx. The stigmata and pouches of the pharyngeal wall can only be observed clearly by removing part of it (including the atrial wall), staining and clearing.

FAMILY CHARACTERISTICS

The family is characterised by the large buccal cavity surrounded by 6, usually large and branched, branchial arms; the large kidney; the reduced pharynx limited to a relatively short band at the proximal end of the gut; the small area of the atrial wall perforated by stigmata; and the small atrial aperture without lobes.

With the exception only of *Oligotrema sandersi* and *O. unigonas* in which they are reduced, the large branchial arms have regular pinnate branches along each side of the central stem. The branches curve in across the flat inner surface of the stem and the whole arm can fold down over the branchial aperture. The extensions of the body wall that form these arms carry with them the extensions of the muscles from the region around the buccal cavity. The arms appear to be homol-

ogous with the branchial lobes of other ascidians. Similar, although less developed, enlargements of the branchial lobes consisting of hollow expansions of the test with evaginations of the body wall extending into them are known in both aplousobranch and stolidobranch, including some molgulid species (e.g. *Molgula sabulosa*, see Kott 1985).

The buccal cavity is lined with test and is homologous with the branchial siphon of other ascidians. It is completely eversible in one species (*Oligotrema sandersi*), forming a proboscis-like structure projecting forward and leaving the branchial arms in a ring around the outside of its base. In *Oligotrema lyra* and *O. unigonas* it is partially eversible.

The musculature of the buccal cavity resembles that of the branchial siphon of other Ascidacea, with longitudinal bands internal to the strong circular muscles that form a sphincter around the branchial opening. The muscles of the arms branch from the circular muscles of the sphincter. Longitudinal and circular muscles are also present around the atrial siphon. Posterior to the siphonal regions, transverse muscles, sometimes interrupted over the sides of the body, are present only in *Oligotrema*; and longitudinal muscles (in two ventral bands) are present only in *Asajirus* n.gen. (see *H. indicus*).

Branchial tentacles are present around the branchial orifice at the base of the buccal cavity only in the genus *Oligotrema*. They are usually irregular and flattened vertically or horizontally.

Although the pharynx is reduced, it has the usual ciliated peripharyngeal band of the Ascidacea which forms a V in the mid-dorsal line behind the dorsal tubercle. There often is a dorsal groove, but a projecting dorsal lamina is not developed. There is a shallow groove in the mid-ventral line in some species, but a true endostyle is not present. *Oligotrema unigonas* is the only species in which the stigmata are reported to directly connect the atrial cavity with the lumen of the pharynx (see Monniot *et al.* 1975). *Oligotrema sandersi* is the only species in which ciliated stigmata have not been detected (see Monniot *et al.* 1975). In most species there are relatively few openings from the pharynx into a system of chambers that penetrate the wall of the pharynx and open into the right and left anterior horns of the atrial cavity by ciliated stigmata. The branchial chambers appear to be homologous with the spaces created by the three-dimensional network of curving branchial vessels on the inner wall of the pharynx of molgulid genera such as *Ascopera* and *Paramolgula* (compare Herdman 1882 Pl. 4, fig. 6 with *Oligo-*

trema lyra, Fig. 2c below). The walls of the branchial cavities are very delicate. Difficulties in their interpretation arise if they are regarded as tubules rather than spaces. Their structure can be observed only in whole, stained mounts, or in sections.

Although Kott (1969) and Monniot and Monniot (1973) refer to the proximal part of the gut (including the pharynx) as muscular, the muscles are confined to the wall of the buccal cavity and the parietal body wall, and are not found in the walls of the gut itself.

The gut is well developed in all species. A wide oesophagus often is flat in preserved specimens but may be cylindrical in life. With the exception of *Oligotrema lyra* and *O. sandersi* the oesophagus is long and vertical, entering a curved stomach in the posterior end of the body. In *O. lyra* and *O. sandersi* the oesophagus is short, about the same length as the pharynx, and the length of the gut is almost completely taken up by a remarkably large stomach. The rectum varies in length and the anus, its border divided into two shallow lobes, opens at the base of the atrial siphon. In one genus (*Asajirus* n. gen.) there is a crescent-shaped opening from the stomach into a large sac-like diverticulum. Its function is not known, although it has previously been referred to as a liver (Oka 1913, Millar 1959, Kott 1969). However, in the examined specimens referred to below the wall of this sac-like diverticulum is delicate, transparent, and it does not appear to be glandular. There is a conspicuous gastro-intestinal gland with its branches spreading over the wall of the intestine in all species except those in the genus *Oligotrema* in which the stomach is large and the intestine and rectum reduced or absent (see *O. lyra*).

There is some evidence that the species of this family are carnivores, actively trapping a range of crustaceans and polychaetes as well as foraminifers (Bourne 1903, Millar 1959, Monniot and Monniot 1968, Kott 1969). Nevertheless, as Millar (1970) observed, the gut contents could have been taken in with bottom deposits or could fall in from above. The hairs on the posterior part of the body indicate that individuals of *Asajirus indicus* (Oka) are vertically oriented, although the orientation of other species, all of which have the atrial aperture at the posterior end of the body, is more problematical. Actually very little is known of the feeding habits of these organisms. The stigmata are ciliated, the pharynx perforated, and a current of water probably is directed through from the pharynx into the atrial cavity. However, the perforated area is very much reduced and these

ascidians probably are not filter feeders. The strong musculature of the buccal cavity and branchial arms suggests active capture of food rather than a passive process of food falling into the open buccal cavity.

Individuals are monoecious, and the gonads usually are paired, one on each side of the body. They are characteristically molgulid-type gonads with a tubular or sac-like ovary opening near the atrial aperture and usually a single cluster of elongate, branched testis follicles, converging to the vas deferens at the proximal end of the ovarian tube. The vas deferens diverges from the ovary, and opens into the atrial cavity independently of the oviducal opening as in many molgulid species (see Kott 1985). In most other families of the Ascidiacea the male and female gonoducts are associated and open adjacent to one another.

The kidney is large and oval, and contains a large concretion. It is found either on the right side of the body anterior to the right gonad or across the ventral part of the body anterior to the stomach. Its exact position varies according to the development of the gut.

The neural complex consists of the usual dorsal ganglion and gland. Although Monniot *et al.* (1975) believe its position to be particularly superficial, it is in the same position in all families of the Ascidiacea — in the body wall beneath the epidermis between the base of the atrial and branchial siphons. The gland is dorsal to, or dorsal and to the right of the ganglion (as in the Molgulidae and other Stolidobranchia) in *Oligotrema* spp. In the new genus *Asajirus* (*> Hexacrobylus*; Oka, 1913) the gland is ventral to the ganglion as in aplousobranch and phlebobranch ascidians (see Goodbody 1974). The neural ganglion has two anterior short, thick nerve trunks, each dividing into three to serve the six branchial arms. Posteriorly there is the usual median visceral nerve (dorsal nerve cord; Monniot *et al.* 1975) and other smaller paired nerves to the atrial siphon and body musculature as in other species of the Ascidiacea (see Goodbody 1974).

The median visceral nerve in *Oligotrema* spp. has nerve cells anteriorly which become less abundant posteriorly, suggesting the posterior extension of the ganglion as in other stolidobranch species with the atrial aperture at the posterior end of the body (see Kott 1985).

PHYLOGENETIC AFFINITIES OF THE FAMILY

As observed by Bourne (1903), Sluiter (1905), Oka

(1913), Hartmeyer (1923) and Kott (1969), genera of the Hexacrobylidae are related to genera in the family Molgulidae, having a kidney primarily on the right side of the body, six branchial lobes (four in other stolidobranch families) and characteristic molgulid gonads. It is distinguished from the Molgulidae by the reduction of the branchial tentacles and branchial sac, and the development of the branchial lobes into muscular branchial arms which are present consistently in the two known genera of the family.

Seeliger (1906), in erecting the family Hexacrobylidae, placed it in a pleurogonoid suborder Aspiraculata, characterised by the absence or rudimentary nature of the stigmata, the presence of the branchial arms, and the position of the gut — behind the pharynx. However, although it is behind the pharynx, the gut bears the same relationship to the atrial cavity as it does in other stolidobranch ascidians; and the other body organs, viz. gonads and kidney, embedded in the parietal body wall alongside rather than posterior to the atrial cavity, are in a similar position relative to the atrial cavity and the gut as in all stolidobranch ascidians. Thus, the position of the gut in relation to the pharynx is the result of the reduction in the size of the pharynx rather than some plesiomorphic change that could justify the establishment of a new suborder.

Perceiving differences in the nervous system, the gut and the position of the kidney, Monniot *et al.* (1975) and Monniot and Monniot (1978) elevated the Hexacrobylidae to a separate class of the Tunicata — the Sorberacea. However, as discussed below, the characters invoked to support this separation cannot be confirmed as real plesiomorphic differences between Hexacrobylidae and the rest of the Ascidiacea.

The principle distinction between Sorberacea and Ascidiacea (Monniot *et al.* 1975) is based on the view that the posterior median nerve in the Sorberacea is homologous with the dorsal strand (sometimes called dorsal cord) of the Ascidiacea. However, the dorsal strand of the Ascidiacea has no neural elements. It extends posteriorly from the duct of the neural gland rather than the ganglion (Goodbody, 1974). Although associated closely with the visceral nerve it consists of histologically undifferentiated cells, and develops independently of the adult nervous system. There is no justification for regarding the posterior median nerve in the Hexacrobylidae as other than the homologue of the median visceral nerve present in all taxa of the Ascidiacea. The nerve cells in the anterior part of this median nerve in *Oligotrema* spp. appear to

indicate a lengthening of the neural ganglion — a commonly occurring phenomenon in species with posteriorly positioned atrial apertures (see *Pyura elongata*, *P. molguloides*; Kott 1985). The neural complex is in the same position beneath the epidermis as it is in other families of stolidobranch and aplousobranch ascidians. The minute cell masses on the posterior median nerve called accessory ganglia (Monniot *et al.* 1975) that were invoked in support of the new class were observed to resemble the cells of the neural gland (Monniot *et al.* 1975) and there seems no reason to regard them as other than 'small accessory neural glands' (Monniot and Monniot 1978, p.206).

The histology and morphology of the gut are variable throughout the Ascidiacea. In the Hexacrobylidae the large stomach is found in only two species, while in others the gut has the usual subdivisions. The branchial sac is reduced, but is not absent in Hexacrobylidae; and differences in the structure of the branchial sac between aplousobranch and molgulid species are greater than those between Hexacrobylidae and Molgulidae. The kidney is usually on the right side of the body, as in the Molgulidae, although variations in development of the gut sometimes force it ventrally and toward the left. The gonads and gonoducts of species of the present family are identical with those found in many species of the Molgulidae (see Kott 1985).

The members of the family Hexacrobylidae are highly adapted, presumably for life at great depths (having been recorded from 94m to about 5000m). Although it is not yet positively demonstrated, they may be adapted for a carnivorous and active predatory habit. Nevertheless the members of the family have closer plesiomorphic characters in common with the Molgulidae than the members of that family have with other families of the Stolidobranchia, especially in regard to the morphology of the branchial sac and gut, the presence of a kidney, the arrangement of the gonads, and the nature of the thin but tough and fibrous test.

The justification for the family Hexacrobylidae separate from the Molgulidae is somewhat problematical. It is retained here as a reflection of the apparently close relationship between its two genera rather than an indication of its phylogenetic distance from the Molgulidae.

The type genus of the family Hexacrobylidae is *Hexacrobylus* Sluiter, 1905 < *Oligotrema* Bourne, 1903.

KEY TO SPECIES OF THE HEXACROBYLIDAE

1. Branchial tentacles present; sac-like divertic-

ulum of gut not present (*Oligotrema*) 2
Branchial tentacles not present; sac-like
diverticulum of gut present (*Asajirus* n. gen.)
..... 5

2. Branchial arms with pinnate branches 3
Branchial arms without pinnate branches 4
3. Testis divided into two; oesophagus short;
rectum vestigial *O. lyra*
Testis not divided into two; oesophagus long;
rectum not vestigial *O. psammalodes*
4. Testis and ovary present on both sides of
body; male follicles not branched; oesopha-
gus short *O. sandersi*
Testis present on both sides of the body, ovary
present only on one side of body; male
follicles branched; oesophagus long
..... *O. unigonas*
5. Ventral longitudinal muscle bands present
along length of body *A. indicus*
Ventral longitudinal muscle bands not present
along length of body 6
6. Testis follicles in two separate clusters
..... *A. dichotomus*
Testis follicles not in two separate clusters ..
..... *A. genosus*

Asajirus n. gen.

Type species: *Asajirus indicus* (Oka, 1913) > *Hexacrobylus indicus* Oka, 1913.

The name *Hexacrobylus* is preoccupied by *H. psammalodes* Sluiter, 1905, type species of the genus *Hexacrobylus*, which is a junior synonym of the genus *Oligotrema* Bourne, 1903. The name of the new genus commemorates Dr Asajiro Oka, the author of its type species.

The genus is characterised by the complete absence of branchial tentacles, a long oesophagus, a large sac-like diverticulum of the gut with a crescent-shaped opening at the base of the oesophagus, a relatively small stomach, a very short pharynx with one or two openings on each side, two stigmata in each anterior horn of the atrial cavity, the atrial aperture projecting forward from halfway down the body, and the neural gland ventral to the ganglion.

The atrial cavity, extending ventrally from the atrial aperture at mid-dorsal level and dividing into

two pouches one passing each side of the oesophagus to terminate anteriorly beneath the pharynx, is smaller than in the genus *Oligotrema* (in which it extends almost the whole length of the body).

The body musculature is strong around the siphonal regions. However, on the sides of the body the longitudinal muscles usually extend only to the level of the posterior end of the pharynx. Only in one species (*Asajirus indicus*) are there also two strong bands of longitudinal muscles, one each side of the mid-ventral line, extending to the postero-ventral part of the body. Unlike the genus *Oligotrema*, *Asajirus* has no transverse muscles on the body other than those around the siphons.

There are 3 species known in this genus.

Asajirus indicus (Oka, 1913) known from 1000 to 5000 m in the central and western Indian Ocean, the tropical eastern Pacific, the Arctic and all parts of the northern Atlantic, and tropical-central and south-western Atlantic. It is very possible that the species will be found to occur in all the oceanic basins. Undoubtedly its remarkable depth range has contributed to gene flow and prevented isolation of its populations.

Asajirus gulosus (Monniot and Monniot, 1984) is known only from 11 specimens from 1800 to 2500 m in the tropical western Indian Ocean.

Asajirus dichotomus (Monniot and Monniot, 1984) is known only from 3 specimens from 3550 m in the Cape Basin (S.E. Atlantic).

Asajirus indicus (Oka, 1913)

Hexacrobylus indicus Oka, 1913, p. 6. Millar, 1959, p. 203; 1970, p. 147. Monniot, C., 1969, p. 184. Monniot, F., 1971, p. 458. Monniot and Monniot, 1968, p. 32; 1970, p. 334; 1973, p. 457; 1974, p. 777; 1984a, p. 198; 1985a, p. 35; 1985b, p. 307.

Hexacrobylus arcticus Hartmeyer, 1923, p. 133. Arnback, 1928, p. 76. Van Name, 1945, p. 442. Monniot and Monniot, 1984b, p. 141; 1985a, p. 34.

Hexacrobylus cunuchus Monniot and Monniot, 1976, p. 658.

Hexacrobylus sp. Kott, 1957, p. 147. Monniot and Monniot, 1982, p. 128 part (specimen 4.5 cm).

Oligotrema psammites: Kott, 1969, p. 168.

DISTRIBUTION

NEW RECORDS: Western Pacific Ocean (34°27'S, 151°27'E — 1200m, AM Y2125, 1 spec*; 38°16.40'S, 149°27.60'E — 800m, MV F53949, 1 spec*; 38°19.6'S, 149°24.3'E — 930m, MV F53948, 2 specs*; 38°21.9'S, 149°20.00'E — 1000m, MV F53947, 3 specs*; 42°2.20'S, 148°38.70'E — 800m, MV F53950, 2 specs*)

PREVIOUSLY RECORDED: Indian Ocean (Sri Lanka —

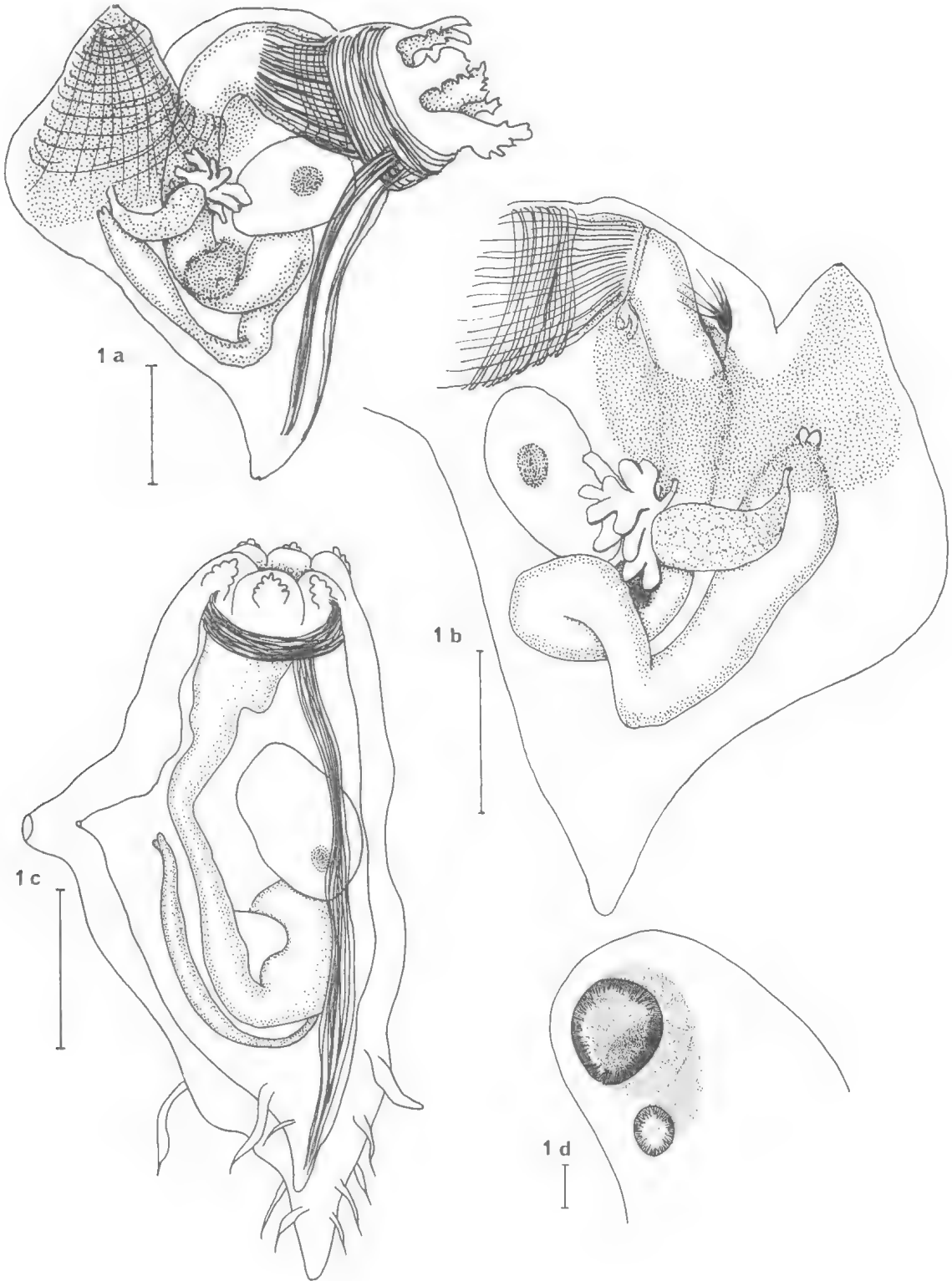
3500 m, Oka 1913. Seychelles — 4340–50 m, Millar 1959, 7 Southern Arabia — 2000 m, Kott 1957. Central and western Indian Ocean — 1300–4283 m, Monniot, C. and F. 1984a; 4280 m, 1985b). Pacific Ocean (tropical E. Pacific — 1892 m, 3659 m, AMNH 2257* 2258 (part)* Millar 1970). Atlantic Ocean (Faroes and Iceland — 891–1264 m, Hartmeyer 1923. N.E. Atlantic — 900 m, Monniot, C. 1969; 2134–4400 m, Monniot, C. and F. 1974; 4190–4480 m, Monniot, C. and F. 1984b; 3859–4435 m, Monniot, C. and F. 1985a. N. central Atlantic — 1200–4692 m, Monniot, C. and F. 1973. N.W. Atlantic — 2496 m, Monniot, C. and F. 1968; 4400 m, Monniot, C. and F. 1985. Tropical central Atlantic — 2022–4892 m, Monniot, C. and F. 1970; 1493–3806 m, Monniot, F. 1971. S.W. Atlantic — 2672–3030 m, USNM 12646* Kott 1969; 2000–5000 m, Monniot, C. and F. 1976; 2195–2323 m, Monniot, C. and F. 1985a).

DESCRIPTION (Fig. 1a–c)

The body is sac-like, usually rounded posteriorly with a beard of fine hairs, to which foraminifers and other particles adhere. In one specimen (MV F53949) the posterior end of the body is drawn out to a point; and one specimen from the tropical Atlantic (Monniot and Monniot 1970) has a long narrow stalk from the posterior end of the body. The branchial opening at the anterior end of the body is a wide, transverse aperture surrounded by branchial arms with regular pinnate branches along each side of the central tapering stem. There are four arms on the ventral side of the branchial opening and two larger arms on the dorsal side. The largest specimen of this species for which the length has been recorded is 2.3 cm long (Monniot, C. and F. 1984a), although one of 4.5 cm (Monniot, C. and F. 1982) may be of this species. The test is thin and translucent.

The atrial siphon is largely internal, only a relatively small conical protrusion being apparent on the surface. Internally it is very variable in length, occasionally being as long as half the body length. It opens about level with the base of the crown of branchial arms. It is probable that in life the atrial aperture is directed upwards and the branchial aperture to the side.

The base of the buccal cavity is surrounded by a sphincter muscle where it passes into the pharynx. Strong longitudinal muscles are present in the walls of the buccal cavity inside the circular muscles. There are also circular and longitudinal muscles on the atrial siphon, the longitudinal ones extending onto the sides of the body over the atrial cavity. Circular muscles are absent from the remainder of the body and the longitudinal musculature is confined to two ventral bands, one each side of the ventral mid-line, that extend into the



(sometimes pointed) postero-ventral corner of the body which is attached to the test, and which fits into the posterior projection of the test when this is present (MV F53949). The atrial cavity envelops the oesophagus from the dorsal surface, separating the parietal body wall from the oesophagus. It extends anteriorly, ventral to the pharynx, in two horns, one on each side.

The neural gland is ventral to the neural ganglion in the interval between the two siphons at the base of the buccal cavity. Its short duct extends ventrally to open into the pharynx by a transverse slit on the small dorsal tubercle. A peripharyngeal groove around the anterior part of the pharynx forms a V in the dorsal mid-line behind the dorsal tubercle. The very short pharynx has on each side, ventrally, a small aperture opening into an anterior and posterior pharyngeal chamber.

The structure of the branchial apparatus in this species is not completely understood. Monniot *et al.* (1975) have demonstrated two openings in a depression (interpreted here as a single opening) on each side of the pharynx, each leading into two large interconnected conical pharyngeal chambers. Each pharyngeal chamber opens into a pocket in the atrial cavity through a horse-shoe shaped ciliated opening (stigmatum). Similar horse-shoe shaped stigmata opening into the anterior horns of the cloacal cavity on each side can be observed in the relatively robust (but rather mutilated) specimen from the South Atlantic (1.5 cm long, USNM 12646). In the smaller (1.0 cm) long specimen from the tropical eastern Pacific (Millar 1959, AMNH 2258) there are two round stigmata, a larger one anterior to a smaller one, in each anterior horn of the atrial cavity. A similar arrangement of stigmata can be seen in one side of the atrial cavity of a small, newly recorded specimens (MV F53948, 4 mm long), although on the other side there is only a single vertically oriented oval stigmatum. The longer stigmata seem to be depressed into the atrial wall for at least part of their length, possibly resulting in the atrial pouches referred to by Monniot *et al.* (1975).

The oesophagus is long, extending most of the length of the body. It opens into a U-shaped stomach enlargement which curves dorsally and to the left before narrowing to the rather long intestine which loops around in the postero-dorsal curve of the body to the base of the atrial siphon where it opens by a two-lipped anus. In larger

specimens (USNM 12646) the anal lips have small secondary lobes. At the base of the oesophagus there is a crescentic opening to a sac-like diverticulum lying transversely across the anterior limb of the stomach between the intestine and the kidney.

The kidney is large and oval, lying anterior and slightly to the right of the gut loop.

The gonads consist of long, branched male follicles in a single clump at the proximal end of each long, tubular ovary. The male follicles converge into the centre of the clump where they join a short vas deferens which opens directly into the atrial cavity. The female openings are near the anus at the base of the atrial siphon.

REMARKS

The specimen from 2672–3030 m north of the South Shetlands (USNM 12646; Kott 1969) was described as having a muscular oesophagus, a glandular diverticulum from the gut, and two large sacs from the pharyngeal region that Kott (*loc. cit.*) interpreted as branchial sacs. This specimen has been re-examined. As Millar (1970) suggested, what Kott called 'pharyngeal sacs' are indeed the atrial cavity. There is a single opening from each side of the gut into the two interconnected chambers each opening into the atrial cavity by a very long curved stigmatum. The more numerous openings (Kott 1969, Fig. 239) appear to be sections of the long curved stigmata. The gut diverticulum and the oesophagus are the same as in the present specimens. The larger of the two specimens from the Antarctic assigned to *Hexacrobylus* sp. by Monniot and Monniot (1982), with its buccal cavity turned to the side, may also be a specimen of *A. indicus*. If so, it is the largest specimen known, having a length of 4.5 cm.

Specimens ascribed to *Hexacrobylus arcticus* Hartmeyer, 1923 have only one distinction from the majority of recorded specimens of this species — they have a longer spermduct. However, they have been recorded from the Faroes and Iceland, and the Bermuda Basin, the north-east Atlantic Basin and North West Atlantic. Thus, specimens with this long oviduct attributed to *H. arcticus* are not from a single isolated population and, in fact, Monniot and Monniot have observed both long and short sperm ducts in specimens from the eastern Atlantic (see Millar 1970). It is more likely, in a species with the wide range of the present one, that there is some genetic diversity, and that the

FIG. 1. *Asajirus indicus* (Oka, 1913): a, individual from right side (AM Y2125); b, body from left side, branchial siphon not shown (AM Y2125); c, individual attenuated posteriorly (MV F53949); d, opening of stigmata into the atrial cavity (MV F53948). Scales: a–c = 1.0 mm; d = 0.1 mm.

long oviduct is a reflection of this diversity, found especially in populations from all parts of the north Atlantic as far south as the Bermuda Basin.

In one of the newly recorded specimens (AM Y2125) there is a large parasitic copepod embedded in the right parietal body wall near the base of the atrial cavity.

***Asajirus gulosus* (Monniot and Monniot, 1984)**

Hexacrobylus gulosus Monniot and Monniot, 1984a, p. 203.

DISTRIBUTION

Indian Ocean (tropical W. Indian Ocean — 1800–2500 m, Monniot C. and F. 1984).

DESCRIPTION (after Monniot and Monniot 1984a including Figs 4 A–D, 5A–B)

Eleven very damaged specimens are known. They are oval, the largest 1.25 cm long. The body has the same branchial arms, test with fine hairs to which foraminifers attach, and mid-dorsal atrial aperture as *A. indicus*. There is neither a stalk nor ventral longitudinal muscle bands. There are two pharyngeal perforations on each side. A very large distended rectum fills the rounded posterior half of the body. There is the usual diverticulum from the stomach that is characteristic of the genus. Both ovary and testis are present on each side of the body. The ovaries are short and sac-like, and the testes follicles are large and branched. Usually the kidney is anterior to the stomach as in *A. indicus*, however, in all except one of the specimens the gut turns to the right rather than the left, and the kidney appears to be more on the left side of the body (Monniot and Monniot 1984a, Fig 4D) than the right (i.e., to the left of the enlarged intestine).

REMARKS

The absence of ventral muscle bands and the short sac-like ovaries in this species and in *A. dichotomus* from the S.E. Atlantic (see below) distinguish them from *A. indicus*. *A. dichotomus* is distinguished from the present species by its two rather than one clump of male follicles on each side of the body.

***Asajirus dichotomus* (Monniot and Monniot, 1984)**

Hexacrobylus dichotomus Monniot and Monniot, 1984, p. 207; 1985a, p. 35.

DISTRIBUTION

Atlantic Ocean (S.E. Atlantic Cape Basin — 3550 m, Monniot, C. and F. 1984, 1985a).

DESCRIPTION (see Monniot and Monniot 1984a including Fig. 6A–D)

Three (one damaged) individuals from 1.0 to 1.2 cm long are known. They are oval, with the usual six branchial arms, a short atrial siphon from the mid-dorsal part of the body, and a thin test with hair-like extensions to which foraminifers are attached. Neither ventral muscle bands nor stalk are present. The rectum is distended, but is not spherical as it is in *A. gulosus*. The ovary is a rather irregular or curved sac. There are two clumps of branched male follicles at the proximal end of each ovary. Each clump of male follicles has a long duct and these join to form a very short vas deferens which opens into the atrial cavity. As in the majority of the specimens of *A. gulosus* the gut appears to turn to the right rather than the left. The kidney, accordingly appears to be the left of the enlarged intestine.

REMARKS

The distinctions between *A. dichotomus* and *A. indicus* are discussed above (see *A. gulosus*). Both *A. gulosus* and the present species have a large swollen rectum. The paired clumps of male follicles constitute the principal character separating *A. dichotomus* from *A. gulosus*. The reversed gut loop reported in this species and in *A. gulosus* appears to be an intraspecific variation, at least in the former species.

***Oligotrema* Bourne, 1903.**

Type species: *Oligotrema psammites* Bourne, 1903.

The genus is characterised by the presence of branchial tentacles which are covered with unusual 'flagellated' epithelium (Bourne 1903). There is no sac-like diverticulum from the stomach, which is sometimes very large. The atrial aperture is always posterior, and posteriorly directed. Individuals are never stalked. Longitudinal muscles are confined to the anterior half of the body, and along the atrial siphon, and long ventral muscles (as in *Asajirus indicus*) are never present. Circular muscles are present along the length of the body, but sometimes are interrupted ventrally over the gut. They are particularly strong across the dorsal border. A limited number of openings from the relatively short pharynx lead into chambers which

open into the top of the right and left horns of the atrial cavity by varying numbers of deep circular ciliated stigmata. Occasionally stigmata open into pouches in the wall of the atrial cavity rather than directly into it (see Bourne 1903, Fig. 26, and *O. lyra*, below). The complexity of the pharyngeal wall appears to increase with the size of the specimens. The walls of the chambers between the pharynx and atrial cavity are very delicate and cannot be observed without staining and clearing. The statement that the 'thick lateral walls (of the pharynx) are honey-combed by a number of irregular, canals and chambers, which recall, more than anything else, the incurrent and excurrent canals of a sponge' (Bourne 1903, p. 255) is to some extent misleading in view of the delicacy of the tissues. In the two smaller species there are variations from the usual condition of the branchial wall — *O. unigonas* has stigmata opening directly from the pharynx to the atrial cavity; and in *O. sandersi* ciliated stigmata have not been detected.

Although he found the neural duct, Bourne apparently did not find the neural gland in *Oligotrema psammites*. He found a 'few small tubules closely applied to the nerve ganglion' containing cells with deeply staining nuclei (Bourne 1903, p. 264). In his specimen neither the ganglion nor the gland were well preserved, and Bourne, expecting the latter to be subneural (as it usually is in other than stolidobranch ascidians), may have overlooked it. None of the published figures in Bourne's work include sections across the neural complex, although there is one across the opening of the duct. In view of the agreement in other characters, it is probable that the arrangement of the neural complex in *O. psammites* would be the same as in *O. psammotodes* with the neural gland dorsal to the ganglion.

Bourne's sections (Bourne 1903, Pl. 20, Fig. 7, Pl. 22, Fig. 26) show stigmata and tentacles that are not incompatible with the circular stigmata and vertically flattened and crowded tentacles found in *Hexacrobylus psammotodes* Sluiter, 1905. Thus, despite his reconstructions of elongate stigmata and branched tentacles (Bourne 1903, Pl. 21 Fig. 16, Pl. 23 Fig. 34), it is probable that neither the stigmata nor branchial tentacles of *O. psammites* type specimen were essentially different from those of *H. psammotodes*. Both species have the characteristic posteriorly-positioned atrial aperture, similar gut, gonads, branchial arms, buccal cavity, and transverse body musculature. Although (on the basis of the shape of the stigmata) there is some doubt about the synonymy

of *O. psammites* with *H. psammotodes*, there is none concerning the synonymy of the genera.

The synonymy suggested by Kolt (1969) is incorrect in that *Hexacrobylus indicus* Oka, 1913 is not a synonym of either *Oligotrema psammites* or *O. psammotodes*. Further, Oka's species is wrongly assigned to *Hexacrobylus* (see *Asajirus*, above).

Generally the species formerly assigned to *Sorbera* Monniot and Monniot, 1974 and *Gasterascidia* Monniot and Monniot, 1968 have all the characters of *Oligotrema*, and their differences do not appear to justify generic status. *Oligotrema psammites*, *Oligotrema psammotodes* (> *Hexacrobylus psammotodes*) and *O. lyra* (> *Gasterascidia lyra*) have identical large pinnate branchial arms and similar gonads with branched male follicles. *Oligotrema sandersi* (> *Gasterascidia sandersi*) and *O. unigonas* (> *Sorbera unigonas*) have characters that probably are associated with their small size — *O. sandersi* having simple branchial arms and an undivided testis, and *O. unigonas* irregularly branched arms and a single branched male follicle. Other characters (in addition to the variations in the pharyngeal wall referred to above) show a gradation throughout the known species: the pharynx is completely eversible in *O. sandersi*, partially eversible (as in *Asajirus*) in *O. lyra* and *O. unigonas*, is not known to be eversible in *O. psammotodes*; and the rectum is very large in *O. unigonas*, of moderate size in *O. psammotodes* and *O. sandersi* and vestigial in *O. lyra*. It is not unlikely that the swollen stomach in species formerly assigned to *Gasterascidia* is an apomorphic character as is the swollen gut in *Ascidia sydneyensis*. Thus both *Gasterascidia* and *Sorbera* are here regarded as junior synonyms of *Oligotrema*.

Monniot and Monniot (1974, 1975) suggest that the minute black sphere that is usually (but not always) present in the neural gland of species assigned to *Sorbera* Monniot and Monniot, 1974, viz. *S. digonus* (< *Oligotrema psammotodes*) and *S. unigonas* (< *Oligotrema unigonas*) may be an otolith, as it resembles the larval otolith present in most larvae of the Ascidacea. However, unless the embryology of these species is different from that known in other ascidians, this cannot be the larval otolith persisting in the adult organism. In those species in which the development of the nervous system has been studied, the cerebral vesicle (the right half of the divided anterior end of the embryonic neural tube) and the posterior end of the embryonic neural tube both degenerate on metamorphosis. The elements of the adult neural

complex (including the neural gland) develop from the persisting left half of the anterior end of the embryonic neural tube (see Berrill 1950). Thus, the neural gland is normally an exclusively adult organ, and the black sphere usually present in some species of *Oligotrema* is probably secondarily acquired. Unfortunately this question cannot be resolved until histological and embryological evidence is available.

Five species of the genus *Oligotrema* are known, of which one, *Oligotrema psammites* Bourne, 1903 is very possibly a synonym of *Oligotrema psammatodes* (Sluiter, 1905). All the species appear to be fairly closely related.

Oligotrema lyra (Monniot and Monniot, 1973) is known from numerous specimens, taken from about 2000 to 5000 m in the north-eastern to north-central Atlantic, the tropical eastern and south-eastern Atlantic, the tropical West Indian Ocean, and the eastern Pacific Antarctic Basin. This species has a wide depth range and appears to have almost as wide a geographic range as *Asajirus indicus* — although it has not yet been recorded from the tropical and northern Pacific Ocean.

Oligotrema psammatodes (Sluiter, 1905) is known from about 1000 to 4000 m in the western Pacific Ocean (off the NSW coast), possibly from Indonesian waters (*O. psammites*), from the tropical West Indian Ocean and the southeastern Atlantic. So far it is recorded only from the southern hemisphere. It is sympatric with *O. lyra* in the West Indian Ocean and the south-eastern Atlantic.

Oligotrema sandersi (Monniot and Monniot, 1968) is known from about 2000 to 5000 m from the north-western, north-central, tropical central, and the south-eastern Atlantic. Its depth range is wide and very numerous specimens have been taken in the north-western Atlantic Basin. So far it has not been recorded outside the Atlantic Ocean.

Oligotrema unigonas (Monniot and Monniot, 1974) is a small species known from about 3000 to 5000 m in the north-central to north-eastern Atlantic, the tropical-eastern and south-eastern Atlantic and the tropical to southern West Indian Ocean. Like *Oligotrema lyra* it is not recorded at all from Pacific Ocean Basins.

Oligotrema lyra (Monniot and Monniot, 1973)

Gasterascidia lyra Monniot and Monniot, 1973, p. 457; 1974, p. 777. 1984a, p. 209. 1985a, p. 35.

DISTRIBUTION

NEW RECORDS: Pacific Ocean (E. Pacific Antarctic Basin 56°05'S, 71°07'W — 2028 m, USNM 18252 3 specs*; 70°06'S, 119°44'E — 3553–3575 m, USNM 18251 1 spec*).

PREVIOUSLY RECORDED: Atlantic Ocean (N.E., N. central Atlantic — 3360–4690 m, Monniot, C. and F. 1973; 4196–4700 m, Monniot, C. and F. 1974; 4217–4829 m, Monniot, C. and F. 1985a. S.E. Atlantic — 4180 m, Monniot, C. and F. 1974; 4600 m, Monniot, C. and F. 1984a; 3550–5260 m, Monniot, C. and F. 1985a. Tropical E. Atlantic — 4019 m, Monniot, C. and F. 1974). Indian Ocean (Tropical W. Indian Ocean — 2300–3716 m, Monniot, C. and F. 1984a).

Previously recorded from the eastern Atlantic and the tropical Indian Ocean, the new records are the first from the Pacific Ocean.

DESCRIPTION (Figs 2a–c)

The newly recorded specimen from the Southern Ocean is the largest known in this family. It is 6 cm long, but mature gonads are present from 4 mm (see Monniot and Monniot 1973). In contracted individuals one third of the length is taken up by the anterior buccal cavity and branchial arms. This anterior third of the body is separated from the remainder by a slight constriction over which the thin test has circular folds. This is the area that becomes long and narrow when the animal is extended, anteriorly expanding out into the branchial crown formed by the 6 branched arms. The branchial arms are relatively even in length, with up to 14 pinnate branches along each side that fold in over the inner surface. The posterior end of the sac-like body narrows to the pointed atrial aperture. The test is thin and translucent, especially on the pinnate branches of the branchial arms. On the posterior sac-like portion of the body there are very thin hair-like processes to which particles are attached. The test lining the buccal cavity has numerous upright oval tubercles (up to 1.5 mm long) constricted at their base. Small tubercles are also present on the inside of the branchial arms. The buccal cavity is partially eversible (see Monniot and Monniot 1973).

Circular muscles form a strong band around the outside of the buccal cavity. There are also circular muscle bands over the remainder of the body. These are interrupted over the ventrum and sides of the body but they are conspicuous along the dorsal mid-line. Strong internal longitudinal bands branch off the circular muscles of the buccal cavity and extend anteriorly to the buccal arms. A set of internal longitudinal bands originating from around the branchial aperture extend on each side to the posterior end of the short oesophagus. There are also longitudinal as well as circular muscles on

the atrial siphon. The muscles of the buccal cavity appear to be indendent of those on the pharynx and oesophagus and they probably effect the eversion of the buccal cavity and the movement of the arms.

At the base of the buccal cavity there is a variable number of antero-posteriorly flattened tentacles. These vary from long strap-like to short triangular shapes, only sometimes with an

irregular slightly forked tip. The longer tentacles are in the ventral mid-line. In the large (6 cm) newly recorded specimen there are about 16 tentacles, but Monniot and Monniot (1973) found only 4 in their small (up to 4 mm long) specimens. There is a narrow pre-branchial region between the tentacles and a peripharyngeal groove that encircles the pharynx, meeting in a V behind the dorsal tubercle in the mid-dorsal line. Longitudi-

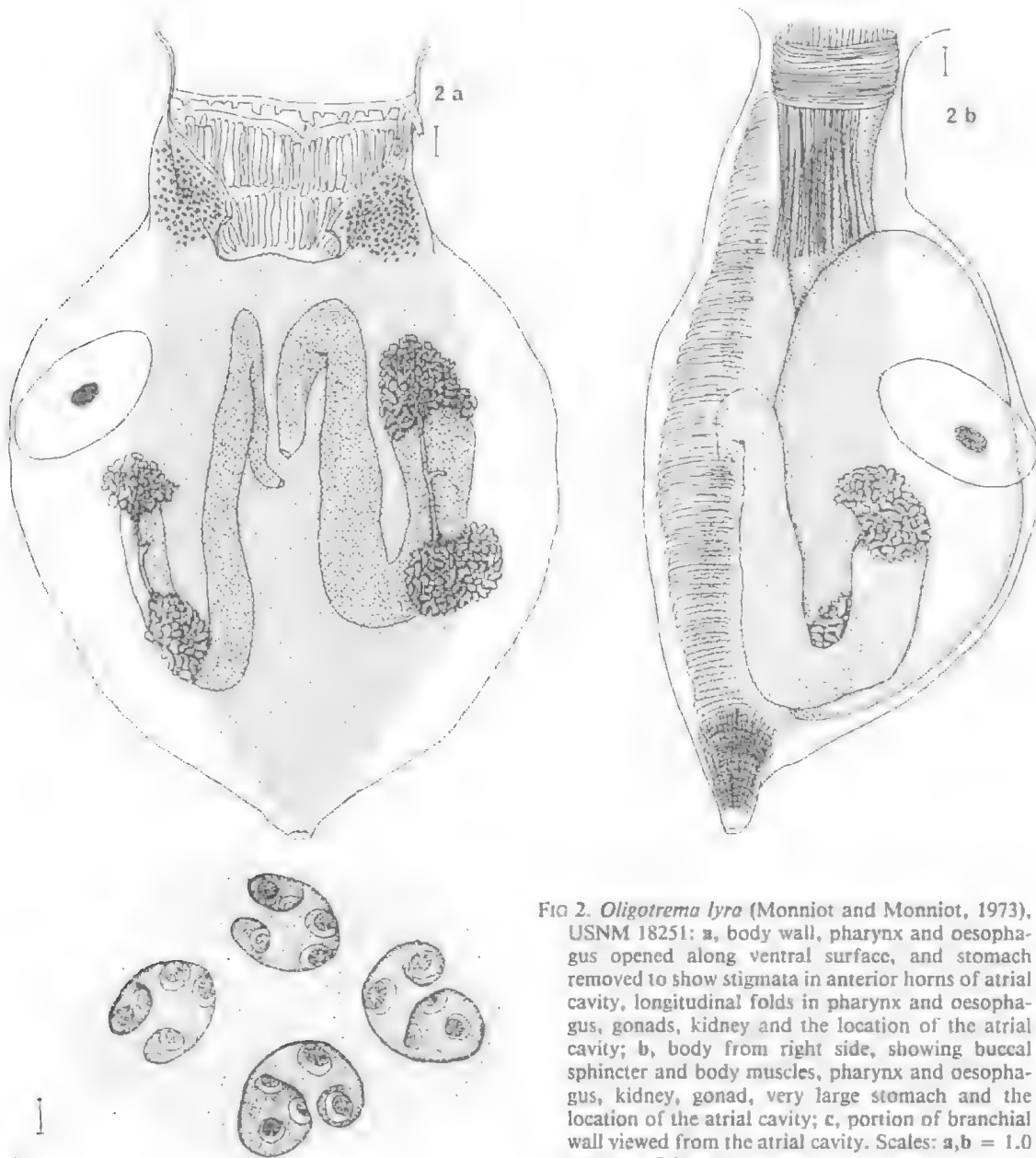


FIG 2. *Oligotrema lyra* (Monniot and Monniot, 1973), USNM 18251: a, body wall, pharynx and oesophagus opened along ventral surface, and stomach removed to show stigmata in anterior horns of atrial cavity, longitudinal folds in pharynx and oesophagus, gonads, kidney and the location of the atrial cavity; b, body from right side, showing buccal sphincter and body muscles, pharynx and oesophagus, kidney, gonad, very large stomach and the location of the atrial cavity; c, portion of branchial wall viewed from the atrial cavity. Scales: a, b = 1.0 mm; c = 0.1 mm.

nal folds in the pharynx are interrupted in the mid-dorsal line. There is also a shallow groove along the mid-ventral line but there is no endostyle.

The walls of the pharynx are raised into longitudinal folds. Between these folds there are patches of pharyngeal wall where, between the meshes of a complex three-dimensional network of curving vessels, there are interconnected canals and chambers that open by circular ciliated stigmata into pouches in the anterior horns of the atrial cavities on each side of the body. There are about 80 to 100 stigmata on each side. The branchial epithelium tends to lift off in the way Bourne (1903) described for *O. psammites*. Monniot et al. (1975) did not observe cilia lining the stigmata although the atrial and pharyngeal pouches are described (Monniot et al. 1975, Pl 5, fig 2).

The pharynx and oesophagus are more or less continuous, and of even diameter. The stomach is very large, occupying most of the body. The kidney lies about half way down the body, across the ventral half of its right side between the stomach and the body wall. In the newly recorded specimen there is a ventral groove in the stomach that terminates in a small pit about one-third of the way up. This pit may be the homologue of the distal opening of the stomach into the rectum. Neither an opening from the stomach, nor a rectum were found in the newly recorded specimen (USNM 18251). Monniot and Monniot (1973) found a very narrow, straight and probably vestigial structure referred to as a rectum, extending dorsally, at first anterior to and then crossing the inside of the right ovary.

The atrial cavity extends from the postero-dorsal aperture around the dorsal half of the stomach (separating it from the gonads which lie in the parietal body wall). Anteriorly it embraces the pharynx and its two anterior horns that receive the openings of the stigmata reach almost to the level of the branchial aperture.

The gonads, one on each side of the body, consist of a long S-shaped ovarian tube which extends postero-dorsally for the middle one third of the length of the body, turns antero-dorsally for an equal distance and then postero-dorsally again before opening into the atrial cavity about halfway down the body near the dorsal mid-line. There are two groups of male follicles. In the newly recorded specimen (USNM 19251), one is at the proximal end of the ovary, and the other at the distal end of the proximal limb. The long ducts from each clump of follicles meet along the mesial surface of the proximal limb of the ovary where they join into a vas deferens of variable length

opening into the atrial cavity. In their small specimens (up to 4 mm) Monniot and Monniot (1973 Fig 32, 33) show the two male glands closer together at each side of the proximal end of the ovary. They have shorter vasa efferentia but a longer vas deferens than in the present large specimen.

The three newly recorded specimens from the eastern Pacific Antarctic Basin (USNM 18252) contain only the two sets of male gonads on each side of the body. The other organs appear to have been resorbed and are replaced by a jelly-like matrix in which the testes are embedded.

In all specimens so far recorded the male openings into the atrial cavity are far removed from the female opening.

REMARKS

The species is distinguished from *Oligotrema sandersi* by its branched rather than simple branchial arms, two rather than one clump of male follicles, longer ovarian tubes bent into S-shapes, more numerous stigmata, and partially rather than completely eversible pharynx. *Oligotrema psammatodes* also has only a single clump of male follicles per side, more numerous tentacles, a longer oesophagus and a smaller stomach than the present species, although it has similar branchial arms. The position of the vestigial rectum of *O. lyra* recorded by Monniot and Monniot (1973) is the same as that of the intestine in *O. psammatodes* with the testis projecting between the stomach and the intestine. However in the newly recorded specimen of *O. psammatodes* the rectum contains faeces, while in the present species it is almost certainly not functional.

The very large stomach and thin vestigial rectum — if one is present at all — are conspicuous features in this species. It is possible that in living specimens the huge stomach is open to the exterior through the wide oesophagus, pharynx and buccal cavity, and that wastes are expelled through the mouth, propelled by the strong muscles across the dorsal surface of the body.

The less numerous branchial tentacles and longer vas deferens of Monniot and Monniot's (1973) small specimens from the north eastern Atlantic may be associated with their size and age, or they may represent intraspecific variations in populations of this widely distributed species.

The 63 unidentified small (0.5–0.7 mm) specimens, *Gasterascidia* sp. Monniot and Monniot, 1976 from the S.W. Atlantic (Argentine Basin), with partly everted buccal cavity and large stomachs almost completely occupying the body,

are possibly this species as Monniot and Monniot (1970) suggest.

Oligotrema psammatodes (Sluiter, 1905)

Hexacrobylus psammatodes Sluiter, 1905, p. 135.
Sorbera digonas Monniot and Monniot, 1984a, p. 209.
 'Hexacrobylidae' juv. intermediate between *Sorbera* and
Gasterascidia Monniot and Monniot, 1984a, p. 212.
 ? *Oligotrema psammites* Bourne, 1903, p. 233.

DISTRIBUTION

NEW RECORD: Pacific Ocean off the NSW coast, 34°27'S, 51°27'E — 1200 m, AM Y2127-B 2 specs*).

PREVIOUSLY RECORDED: Pacific Ocean (? New Britain — 92 m, Bourne 1903; Laut Banda — 1158 m, ZMA TU564* Sluiter 1905). Indian Ocean (tropical W. Indian Ocean — 3700–3716 m, Monniot, C. and F. 1984a). Atlantic Ocean (Cape Basin — 4,600 m, Monniot C. and F. 1984a).

DESCRIPTION (Fig. 3a–e)

There are 2 newly recorded specimens, both about 2 cm long. The three previously recorded specimens (Monniot and Monniot 1984a) are from 12 mm to 17 mm long, and the type specimen (Sluiter 1905) is the largest known with a length of 3.2 cm. Specimens have the typical appearance of Hexacrobylidae with 6 large branchial arms (with pinnate branches) around the rim of the buccal cavity. The atrial siphon is from the dorsal aspect of the posterior end of the sac-like body. The buccal cavity does not appear to be eversible.

In the two newly recorded specimens and in the type there is a crowded ring of vertically flattened, sessile scale-like projections just inside the mouth opening (at the base of the buccal cavity). They are convex on their outer border and have a finger-like tentacle from the upper border which alternates with similar finger-like tentacles that arise directly from the wall of the lumen of the pharynx. These structures are similar to those described for the hexacrobylid juv. that Monniot and Monniot (1984a) regarded as halfway between *Sorbera* and *Gasterascidia*. They also resemble some of the tentacles that are shown on the tentacular ring of the figured specimen of *Sorbera digonas* (Monniot and Monniot 1984a Fig. 8e).

There is a shallow prebranchial region, and a peripharyngeal groove forming a deep V behind the small dorsal tubercle, on which the short duct of the neural gland opens in a transverse slit. There is an oesophageal groove in the dorsal mid-line. There is a fine very shallow groove in the ventral mid-line but no endostyle. The neural gland is

dorsal and to the right of the neural ganglion. There is a minute black sphere in the dorsal gland of one of the two newly recorded specimens but not in the other. A similar black spot is present in the type specimens of *Sorbera digonas* Monniot and Monniot, 1984a and in the unidentified juvenile from the Cape Basin (Monniot and Monniot 1984a).

The pharynx is short, and its lining is longitudinally folded. Between the folds there are a number of swirling openings leading into the interconnected chambers that open by numerous circular ciliated stigmata directly into the two anterior horns of the atrial cavity around the sides of the oesophagus. Superficially the branchial wall of the newly recorded specimens resembles that figured by Monniot and Monniot for the hexacrobylid they believed to be intermediate between *Gasterascidia* and *Sorbera* (see Monniot and Monniot 1984a Fig. 9c). However, stained and cleared whole mounts of pharyngeal wall show it to have, as in *Oligotrema lyra*, swirling vessels encircling the spaces through which the stigmata are connected to the lumen of the pharynx rather than the branching tubes that Monniot and Monniot (1984a Fig. 9) have figured. The only difference from *O. lyra* is the absence of pouches in the atrial wall of the newly recorded specimens of the present species. The number of stigmata in the present species is variable. Specimens from the Indian Ocean up to 1.7 cm long have up to 20 stigmata on one side and 14 on the other. The largest of the new Australian specimens have about 60, and in the large type specimen (ZMA TU564) they are more numerous.

The oesophagus is long, constricted from the branchial sac, and enters the posterior dorsal half of the stomach about two-thirds of the way down the body. The stomach then curves anteriorly and to the right, its ventral and right wall being deeply convex externally. The long intestine leaves the stomach at the anterior end, extends around the left ventro-posterior curve of the body, gradually expanding into a rather swollen rectum opening near the base of the atrial siphon. In the newly recorded specimens the rectum contains faeces.

The large oval kidney is on the right side of the body in front of the stomach.

A male and a female gonad are present on each side. The male follicle is at the proximal end of the ovary. It consists of long finger like branches converging to a short vas deferens that opens into the atrial cavity — in the vicinity of the pole of the gut loop on the left, and near the posterior end of the kidney and the anterior border of the stomach on

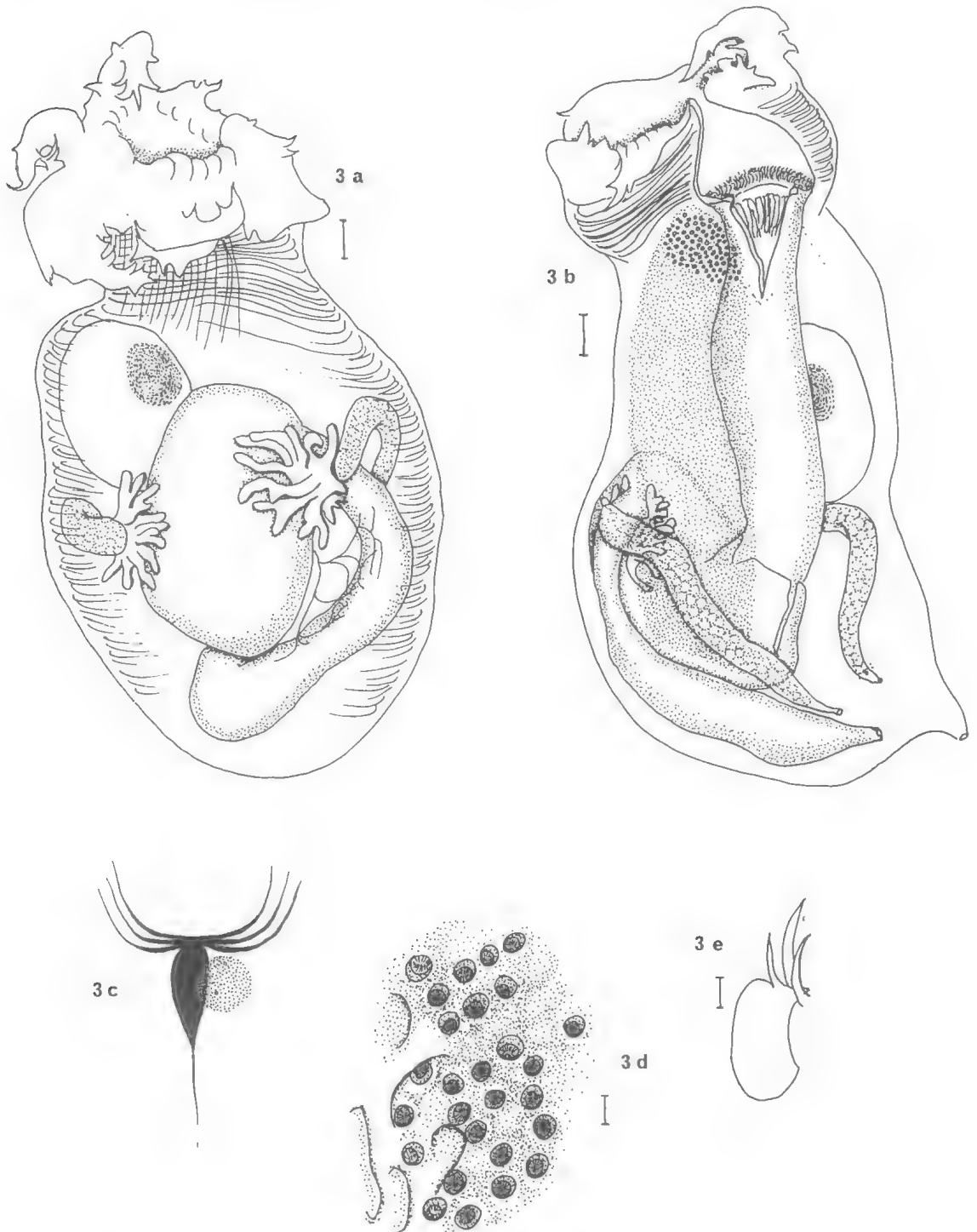


FIG 3. *Oligotrema psammatodes* Sluiter, 1905 (AM Y2127): **a**, individual from the ventral surface; **b**, individual from the left side, with pharynx and anterior part of oesophagus opened, the shaded area representing the ventral ligament that divides the left from the right branches of the atrial cavity; **c**, neural gland and ganglion from dorsal surface; **d**, portion of branchial sac showing openings from pharynx, and stigmata seen through the pharyngeal wall; **e**, branchial tentacle. Scales: **a, b** = 1.0 mm; **d, e** = 0.1 mm.

the right. On the left the branches of the male gland lie on the antero-mesial part of the stomach wall, spreading around between the intestine and the stomach. On the right they spread out over the postero-dorsal part of the stomach and onto the kidney. The right ovarian tube curves antero-dorsally from the middle of the right side of the body, and then posteriorly to the base of the atrial siphon. The left ovarian tube curves around the body parallel and slightly anterior to the intestine and rectum.

The atrial cavity is large, embracing the dorsal surface and sides of the oesophagus, the mesial wall of the stomach on the left and separating the stomach and oesophagus from the kidney on the right. The ventral halves of the right and left horns of the atrial cavities are separated by a long ligament attaching the oesophagus to the ventral body wall.

On each side there is a long endocarp-like thickening of the parietal body wall, one projecting into the atrial cavity along each side of the oesophagus, sometimes with parts of the gonad embedded in them.

REMARKS

The species is characterised by its deep peritubercular V, large atrial cavity, single clump of branched testes follicles that project through the gut loop on the left, numerous stigmata opening into the anterior horns of the atrial cavity, long oesophagus, and the absence of atrial branchial pouches. The number of stigmata and the condition of the branchial tentacles appear to be variable.

The pinnate branchial arms, and transverse muscles across the dorsal surface of the body resemble those of *Oligotrema lyra*.

The single specimen of *Oligotrema psammites* was 17 mm long, falling within the recorded range for this species. Bourne's specimen had numerous branchial tentacles which in the sections figured are consistent with those of the present species. The restraints to considering the species to be a synonym of the present one lie principally in the shape of the stigmata which Bourne (1903) believed to be elongate rather than circular. However, as discussed above (see *Oligotrema*) there is some room for doubt as to their shape and it is not impossible that *O. psammites* is the senior synonym of this species, all other characters being in agreement. Bourne's specimen had endocarp-like thickenings of the body wall as in the newly recorded specimens described above.

The newly recorded specimens agree in every respect with the type specimen (ZMA TU564) — which is in excellent condition.

There is some difficulty in reconciling the account of the branchial sac of the type specimen of *S. digonas* (see Monniot and Monniot 1984a Fig. 8d) with the newly recorded specimens. In the latter specimens and in the type the stigmata open into the extremely concave anterior horns of the atrial cavity, not directly through the walls of branchial pouches as the Monniots' figure implies. It is possible that the pharyngeal pouches figured by the latter authors have evaginated into the atrial cavity obscuring their structure and causing them to appear as sacs (protruding into the atrium?)

Oligotrema sandersi (Monniot and Monniot, 1968)

Gasterascidia sandersi Monniot and Monniot, 1968, p. 36; 1970, p. 334; 1974, p. 777; 1985a, p. 35.
? *Gasterascidia sandersi*; Millar, 1970, p. 148.

DISTRIBUTION

Atlantic Ocean (N.W. and N. central Atlantic — 2200–5020 m, Monniot, C. and F. 1968, 1970, 1974, 1985a; Monniot 1971. Tropical central Atlantic — 1493–3783 m, Monniot 1971. ? S.E. Atlantic — 4618 m, Millar 1970).

DESCRIPTION (after Monniot and Monniot 1968, 1973 Fig. 33B, 1975)

Individuals larger than 3.0 mm have not been taken. The long, cylindrical branchial siphon is about half of that length. The short cylindrical atrial siphon is at the posterior end of the body. The branchial arms around the edge of the buccal cavity are simple pointed and pointed tubercles are present in the siphon lining behind the branchial arms. At the base of the buccal cavity there are four very small tentacles. The neural gland is to the right of the ganglion. The opening of the neural duct is on a small tubercle in the mid-dorsal line behind the ring of tentacles. The pharynx is represented by a narrow band around the proximal end of the gut with its wall thrown up into vertical folds which continue into the short oesophagus. Two non-ciliated openings on each side of the pharynx lead, by short tubules, into the anterior horns of the atrial cavity.

The large stomach occupies most of the body, leaving a small space anterior to it where the kidney is placed horizontally across the ventral surface. The oesophagus opens into the stomach about halfway down its dorsal surface. The rectum is a thick, cylindrical tube which extends posteriorly from the right side of the stomach to the atrial cavity.

There is a male and female gonad on each side of the body. Each female gonad is a short ovarian tube extending dorsally around the posterior end of the stomach, separated from it by the atrial cavity on each side. The male gonad consists of a single unbranched male follicle with a fairly short duct that opens into the atrial cavity about halfway along the ovary. Individuals appear to mature rapidly, reaching sexual maturity at 1.5 mm long.

REMARKS

The species resembles *O. unigonas* in its simplified branchial arms, few stigmata and small body. However in *O. unigonas* the stomach occupies only half of the body and the oesophagus the other half. In the present species the oesophagus is relatively short and the stomach occupies most of the body. The undivided male follicles in the present species are unique, as are the unbranched pointed branchial arms and pointed tubercles in the extrudible siphon lining.

The course of the branchial tubules through the thickness of the pharyngeal wall has not been described, nor have ciliated stigmata been detected in this species. Despite this, Monniot *et al.* (1975) regard the branchial apparatus as similar to that of *Oligotrema lyra*, differing only in the reduced number of tubules in the present species.

Oligotrema unigonas (Monniot and Monniot, 1974)

Sorbera unigonas Monniot and Monniot, 1974, p. 777.
Monniot and Monniot, 1984a, p. 209; 1985a, p. 35; 1985b, p. 307.

DISTRIBUTION

Atlantic (N. central to E. Atlantic — 4100–4452 m, Monniot, C. and F. 1974; 3338–4465 m, Monniot C. and F. 1985a. Tropical E. Atlantic — 3138–4019 m, Monniot, C. and F. 1974. S.E. Atlantic — 4600 m, Monniot C. and F. 1984a, 1985a). Indian Ocean (Tropical to S.W. Indian Ocean — 2608–5043 m, Monniot, C. and F. 1984a).

DESCRIPTION (after Monniot and Monniot 1974 including Fig. 23A,B; Monniot *et al.* 1975)

Individuals are known up to 9 mm in length, narrowing to the small atrial aperture at the postero-dorsal end of the body. The cylindrical branchial siphon is at the anterior end of the body with 6 large papillated branchial lobes around its rim. These are not pinnate as they are in other species of the Hexacroblyidae. The test is covered with fine hair-like extensions to which foramina-

fers are attached. The buccal cavity is partially eversible.

The body wall is delicate and transparent. It has yellowish-green granules embedded in its outer layer (as described for *O. psammites* Bourne, 1903). The longitudinal muscles radiate from the branchial siphon to the vicinity of the stomach, and transverse muscles are present over the length of the body.

The neural gland is dorsal and to the right of the ganglion. A small black particle, referred to by Monniot and Monniot (1974) and Monniot *et al.* (1975) as an otolith, is present in the neural gland. There are only 4 to 8 minute branchial tentacles reported. Behind these, the prepharyngeal band forms a deep, narrow V behind the small dorsal tubercle, and in the mid-ventral line it forms a short ciliated groove that may be the homologue of the endostyle.

The pharynx of this species is clearly seen through the body wall. It is cone-shaped. Anteriorly it has longitudinal folds (possibly the result of contraction: Monniot *et al.* 1975). Posteriorly (the base of the cone) the wall of the pharynx is slightly convex, pierced by the oval oesophagus in its mid-dorsal radius, and by 3 to 8 irregular ciliated stigmata per side. The stigmata open into the anterior horns of the atrial cavity which extends anteriorly around each side of the oesophagus to terminate just behind the posterior wall of the pharynx. The stigmata are said to open directly into the cloacal cavity.

There is a relatively narrow oesophagus opening into a large almost spherical stomach (in the postero-ventral part of the body) about halfway along its dorsal border. The short cylindrical rectum curves either to the left or the right and posteriorly from the anterior part of the stomach. The kidney is on the right side of the body anterior to the stomach.

A tubular ovary is present only on the right side of the body, curving dorsally and posteriorly to open into the atrial cavity near the atrial aperture. A single large branched male follicle is also present on the right side of the body spreading over the stomach wall at the proximal end of the ovarian tube. There is a smaller male follicle on the left between the stomach and the rectum. There is no ovarian tube on the left.

REMARKS

The species is distinguished from others by the absence of regular pinnate branches on the branchial arms, the limited number of ciliated stigmata in the posterior rather than anterior part

of the pharynx, and the unpaired ovary on the right side of the body. Although the oesophagus is longer than in *Oligotrema lyra* and *O. sandersi*, the stomach is also relatively large — a character which helps to distinguish the species from *O. psammotodes*. The pharyngeal pouches that are present in *O. psammotodes* and *O. lyra* have not been observed in the present species, in which the pharyngeal perforations are said to open directly into the atrial cavity.

ACKNOWLEDGEMENTS

I thank Dr Robin Millar of the Dunstaffnage Marine Research Laboratory, Oban, whose contribution of ideas and observations on these organisms have significantly advanced my own understanding of them. I am also grateful to Dr A. Pierrot Bults of the Zoological Museum, University of Amsterdam, for the loan of the type specimen of *Hexacrobylus psammotodes* Sluiter, 1905; and to Linda Cole of the US National Museum for the loan of *Oligotrema psammites* Kott 1969.

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CORAL ASSEMBLAGES OF MORETON BAY, QUEENSLAND, AUSTRALIA, BEFORE AND AFTER A MAJOR FLOOD

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The scleractinian coral assemblages of coral reefs inside and outside a bay on the east coast of temperate Australia were examined before, immediately after, and seven years after a major flood. Of the 25 fringing reefs flourishing inside the bay, 15 were killed by flood water. Seven years later, recolonization on a single reef reflects aspects of its original nature. The reef outside the bay was not damaged by the flood and provides insights into factors conditioning the bay's coral assemblages. Comparison between the recent and subfossil reefs gives evidence for a long term change in the Bay environment.

□ *Scleractinia*, corals, fringing reefs, coral reefs, coral death.

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The diversity of genera and species of scleractinian corals attenuates with increasing latitude along the east Australian coast (Wells, 1955b; Veron, 1974; Veron, 1986). Moreton Bay is an area of particular interest because of its extra-tropical location and the simultaneous presence of two assemblages. One assemblage comprises the subfossil remnants within the bay and as a living reef outside the bay at Flinders Reef. The other comprises the living bay corals which represent a reduction in species number and change in dominance from a period of greater richness and abundance (Wells, 1955a).

The dominant species in the subfossil and modern assemblages differ at the subordinal level. The subfossil assemblage is characterized by the suborder Astrocoeniina, containing the genera common to the Indo-Pacific province, e.g. *Stylophora*, *Pocillopora* and *Acropora* (Stehli and Wells, 1971). The present assemblage is characterized by the suborder Faviina with overwhelming dominance by *Favia speciosa*. Though components of the Indo-Pacific subprovince presently exist, the composition conforms to the proposed 'southwestern subprovince' of Stehli and Wells (1971). Subsequent work at the species level has questioned the validity of this distinction on a regional basis (Veron, 1986).

This paper investigates the change in the coral assemblages of Moreton Bay by examination of those inside the bay and by comparing them with Flinders Reef outside the bay. Re-examination of the assemblages after a major flood in 1974 and assessment of recolonization seven years later has lead to speculation about their nature, both past and present.

PRESENT REEFS

The reef structures formed in Moreton Bay are fringing reefs. They differ from their consolidated tropical offshore counterparts by being composed of unconsolidated coral rubble mixed with terrigenous sediments. This rubble is predominantly subfossil in composition and is overlain by the recent living assemblages (Fig. 1). These recent reefs therefore may be defined more appropriately as 'coral communities' after Wainwright (1965) whose definition described coral assemblages growing on a substrate other than that of its own production.

EARLY HISTORY

Throughout the late Quaternary (7×10^5 years B.P.) sea level fluctuated between present MSL and -150 m (Chappell, 1981). Moreton Bay was drained and filled repeatedly. Little evidence remains of the effects this may have had on earlier Pleistocene reef development. A late Pleistocene coral fauna (1.2×10^5 years B.P.) from tidal level at Evans Head (Pickett, 1981) and similar material from North Stradbroke Island (Pickett *et al.*, 1985) provide evidence of local coral occurrence prior to the development of the Holocene reefs (< 8,000 years B.P.).

Information on sea-level changes and radiocarbon dates provide some reasonable estimates of the age of Holocene reefs. It is accepted that Moreton Bay lies on the margin of the stable Maryborough Basin (Hill and Denmead, 1960) and that tectonic movement has not greatly biased the evidence in support of eustatic flux.

The reefal thickness of Mud Island reef extends to a depth of 6 m (Richards, 1931) and 5-7 m depth



FIG 1. Present coral assemblage on the northern margin of Peel Island.

was ascertained for Moreton Bay's southwestern shore deposits (Flood, 1978). Most of the bay's coral facies appear to begin at 3–4 m (Andrew, 1964; Smith, 1973). This level has been related to a Holocene shoreline dated 7,500 years B.P. (Wood, 1972). This date agrees with the eustatic curve of Thom and Chappell (1975) showing initial colonization at 7 m below the present mean sea level.

The oldest direct evidence of post glacial transgression is a radiocarbon date of $6,250 \pm 135$ years B.P. (SUA 857) from an *in situ* colony of *Favia* sp. from eastern Peel Island (Hekel *et al.*, 1979). Other evidence of reef development from an earlier period comes from samples dated between $6,000 \pm 3,710$ years B.P. (Rubin and Alexander, 1958; Marshall, 1975). Additional evidence for a Holocene eustatic high are the occurrences of *in situ* coralla in the intertidal zone near Cassim Island (Friederich, 1978) and the subfossil deposits in the southern and mainland margins of Moreton Bay (Andrew, 1964) where recent coral is now scarce or absent (e.g. Coochiemudlo, Macleay, Perulpa/Lamb Islands and the Pelican Banks).

Evidence from a Moreton Bay site dated 4,600 years B.P. suggests that an eustatic high of 1 m above present MSL existed (Jones *et al.*, 1978). The most convincing estimate of a late postglacial high sea level of +2 m was from mollusc shells in a stand of beachrock dated at $2,540 \pm 85$ years B.P. (Lovell, 1975b).

SUBFOSSIL REEFS

Massive coral banks around Mud Island attest to the dominance by the genus *Acropora* and to the degree of reef development (Fig. 2). Subfossil coralla exist on all of the present reef areas with recent species often growing on them.

Estimates of reefal deposits by the Queensland Cement and Lime Co. provide a measure of their former extent: 3×10^{10} kg of reefal limestone occur on the western perimeter of the bay (e.g. Raby Bay, Cleveland Bay and Wellington Point), 2.4×10^8 kg are estimated for the southern bay areas (e.g. Coochiemudlo, Macleay, Perulpa Island and the Pelican Banks). Quantities extracted from Mud Island in the central bay region were 6×10^6 kg in a 6 year period (approximation from Queensland Cement and Lime Co., 1971). None of these areas now exhibit substantial reef development.

Comparing the information on reefal deposits with that of the present survey two points become clear; 1, the subfossil reefs developed unequally,

forming the basis of recent reef areas; 2, the subfossil reefs were more extensive throughout the bay and occurred in areas where there is no present development (e.g. southern bay areas).

METHODS

SITES

Moreton Bay is a wedge shaped body of water, bordered by the Australian mainland to the west and the islands of Moreton and Stradbroke to the east. Open communication with the oceanic waters of the north Tasman Sea is mainly through the northern 13 km wide passage. The southern end terminates in a complex network of channels. The reefs studied are present around the islands of Mud, St Helena, Green, King, Peel, Bird and Goat, Cassim, Coochiemudlo, and the western mainland at Raby Bay and Myora on Stradbroke Island (Fig. 3). Flinders Reef is located 1.5 km NE of Cape Moreton on Moreton Island. It is principally a sandstone outcrop exposed at low tide and surrounded by a diverse coral assemblage.

ASSESSMENT OF THE PRESENT ASSEMBLAGE

Species composition was assessed by placing four m² quadrats every 10 m along transect lines, oriented perpendicular to the shore and extending to the bayward limit for each assemblage. The number of colonies of each species was recorded. An individual colony was defined as any specimen growing independently of its neighbour and having more than half of its area inside the quadrat. The species diversity measure used was that after Brillouin (1962). The percentage of living coverage was determined by the use of the line transect method of Loya (1972) where the presence of a colony under the transect line was measured and noted as a proportion of the whole line. Selection of the sample areas was made in areas of maximum reef development. The survey was carried out during 1972 and 1973.

ASSESSMENT OF THE POST FLOOD ASSEMBLAGE

In January–February 1974 the greatest flood of this century in Queensland occurred in the Brisbane Basin (Beattie, 1980). The survey sites were revisited in April. Mortality following flooding was determined by visual inspection of the original transect areas. The complete or minimal nature of the flooding mortality in most areas allows confidence in this method. Initial line transects were run to verify the subjective estimations.

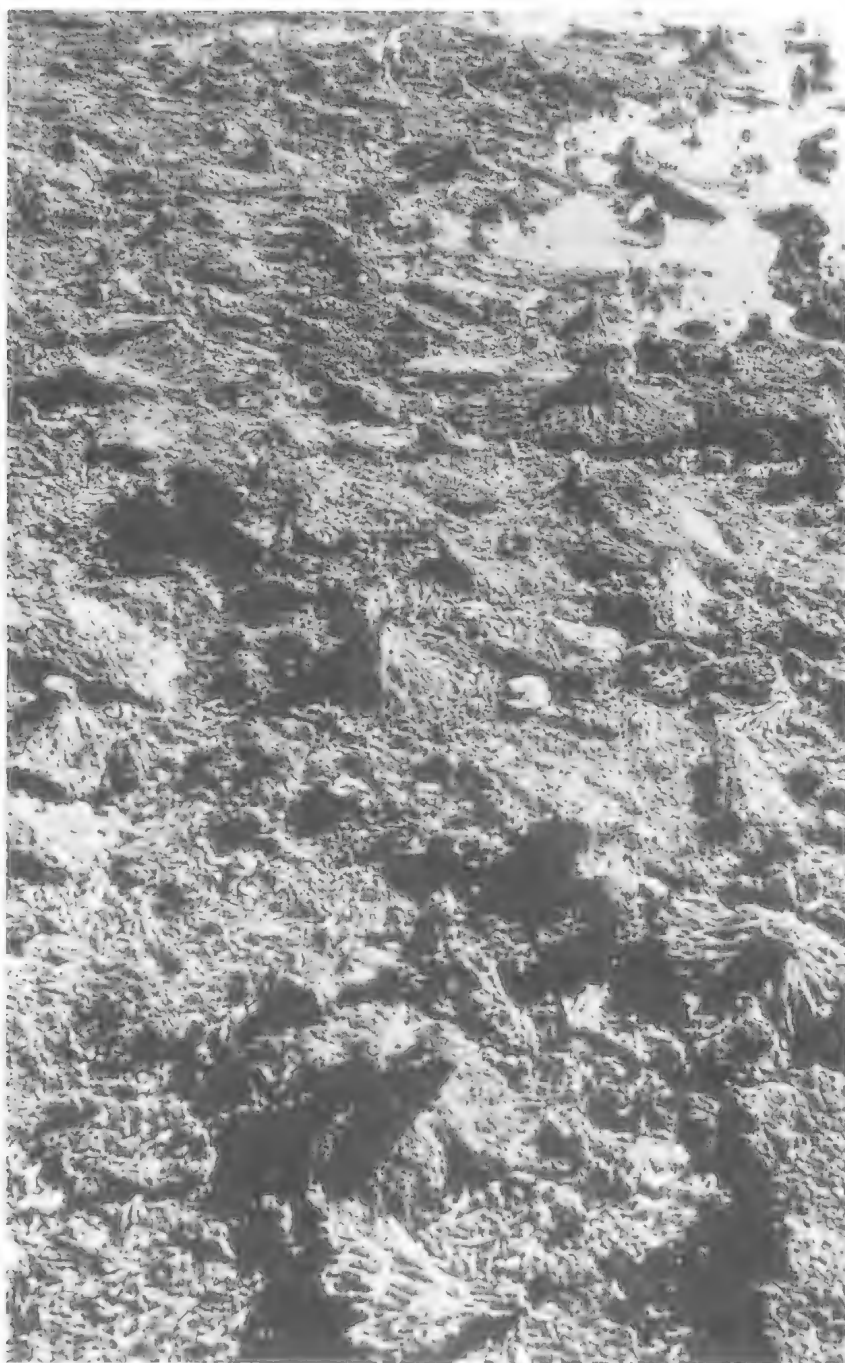


FIG 2. Subfossil coralla, mostly *Acropora* spp., comprise the reefal material around the islands in Moreton Bay (Photo: Mud I.).

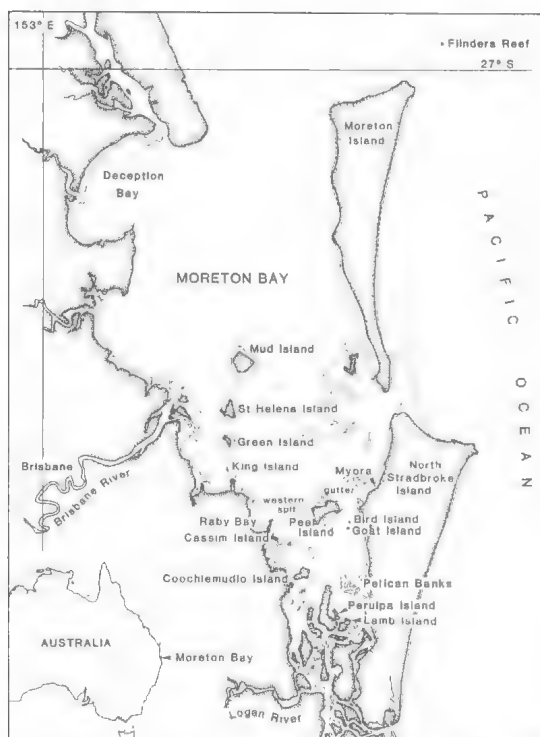


FIG 3. Chart of Moreton Bay, Queensland.

ASSESSMENT OF RECOLONIZATION

In May 1981, seven years after the flood, a site was chosen which had experienced total flood mortality. The site was surveyed in the original manner. Eighteen quadrats (72 m²) were sampled. Comparison was made with the original transects in terms of species number, diversity (H), evenness (J) and the percentage of living cover.

The *Favia speciosa* in the sample were measured. From the colony diameters, the age class distribution was determined and the periods of recruitment assessed.

RESULTS

CORAL COMPOSITION BEFORE THE 1974 FLOOD

Of the 27 species of hermatypic scleractinia in the bay, 26 occur in the subfossil and 18 in the current assemblage (94% co-occurrence) (Appendix). Twelve species were recorded in the quadrat analysis and five noted only as site records. *Favia speciosa* occurred in 93% of transects, representing in terms of absolute numbers, 6391 colonies or 89.4% of the bay samples. *Goniopora lobata*, comprising 296 colonies or 4.1%, was second in abundance. It occurred in 68% of the transects. Next most

abundant and present in 35.2% of the transects were *Favites halicora*, *Favites abdita* and *Turbinaria peltata*. They represent 1.8%, 1.4% and 0.9% of the bay samples, respectively. Table 1 summarizes the species presence at the bay sites with the localities ranked with respect to number of species present. Site species diversity (H), evenness (J) and the percentage of coral cover are noted.

Species rich areas are found at Peel, Bird and Goat Islands and prior to the 1974 flood the eastern reef of Green Island (Table 1). Peel Island had the most species (16), three of which are unique to this location. All other bay sites comprise a reduced component of this assemblage. *Favia speciosa*, *Goniopora lobata*, *Favites abdita*, *Turbinaria peltata* and *Cyphastrea serailia* were the principle elements of the near mainland and northern island sites.

112 species were found at Flinders Reef. As with the subfossil assemblage this was dominated by *Acropora*. Only two species, *Acropora digitifera* and *Favia stelligera*, occurred in the bay's past and present corals but 4 were absent from Flinders Reef.

CORAL ASSEMBLAGES AFTER THE 1974 FLOOD

All coral assemblages on the mainland side of the bay experienced 100% mortality (Fig. 4). The islands of Mud, St Helena and Green also had extensive mortality with the exception of the deep reef on the eastern side of Green Island. Partial or no mortality occurred in the eastern bay in areas of relic water (Stephenson, 1968) and in those sites buffered by depth.

In areas of partial mortality, coral deaths were confined to particular genera. Portions of colonies were often killed. Death was characterized by a fleshless, silt covered corallum. Coral mortality was not confined to the species *Favia speciosa* (cf. Slack-Smith, 1959). On the contrary, the species *Turbinaria peltata*, *T. frondens* and *Goniopora lobata* were most affected by the flooding influence. This was unexpected as these genera are some of the most abundant in the bay, often occurring in the western sites. Mortality on the deep reef on the eastern margin of Green Island was partial. The hardest species in terms of survival was *Psammocora contigua* which averaged 50%. *Favia speciosa* in this area was more greatly affected with a mortality estimated at 70%.

The extent of coral mortality correlated highly with species diversity and percentage of living cover. Areas of low diversity (0.15) generally experienced total mortality. They comprised one

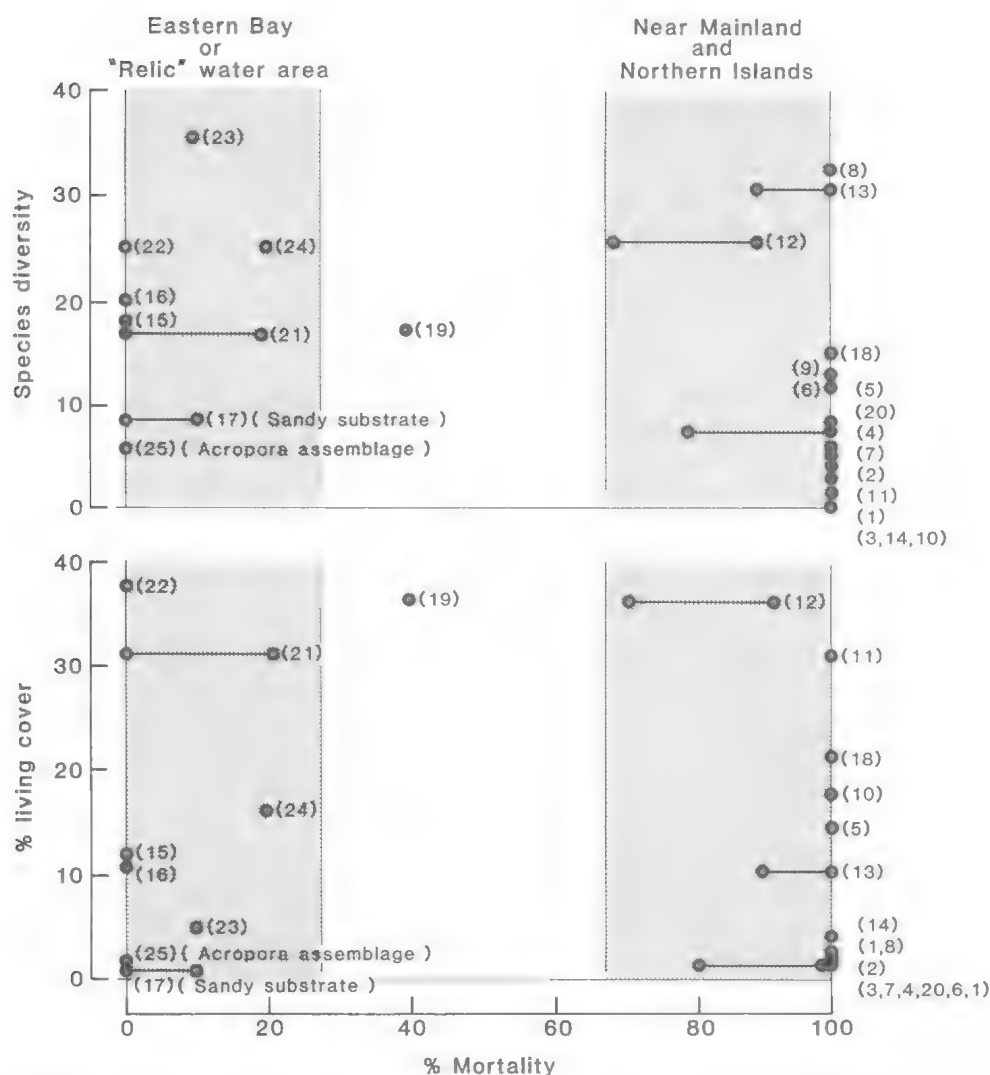


FIG 4. Post-flood mortality related to species diversity and percentage of living cover. Shaded areas contrast the marked flood effect in near mainland areas with those sites buffered by distance or circulation patterns. The bracketed numbers refer to the sites in the legend. Site legend: Western Bay Sites: 1. Raby Bay, 2. King Island; Southern Islands: 3. NE Coochiemudlo Island, 4. N Coochiemudlo Island, 5. Cassim Island; Northern Bay Islands: 6. SW Mud island, 7. N St Helena Island, 8. NE St Helena Island, 9. SE St Helena Island, 10. SW St Helena Island, 11. N Green Island, 12. E Green Island, 13. SW Green Island, 14. W Green Island; Central Bay: 15. N Peel Island, 16. NE Peel Island, 17. E Peel Island, 18. SW Peel Island, 19. SW Peel Island, 20. W Peel Island, 21. NW Peel Island, 22. 'Submerged Reef'; Peel Island: 23. Bird and Goat Island, 24. Bird and Goat Island, 25. Myora 'coral patch'.

to six species and generally had a low percentage of living cover. Exceptions to these trends were: 1, Low diversity assemblages at Myora (0.064) and at the eastern side of Peel Island (0.090) which experienced no mortality; 2, High diversity areas

with a low percentage of living cover such as southeast Green Island and northeast St Helena Island where a high degree of mortality was experienced; 3, High mortality occurring in areas of high living cover having low diversity.

CORAL RECOLONIZATION TO 1981

343 specimens were sampled from SW Peel Island. Seven species were found, two more than the pre-flood condition (Table 2). The species diversity (H) is 0.12 (0.15 pre-flood). Evenness is 0.16 (0.24 pre-flood) (Table 2).

Frequency distribution of diameters provides evidence that recruitment commenced during the reproductive period following the flood (November, 1974). The range in growth indicates that recruitment has occurred in each year (Fig. 5).

TABLE 2. Pre- and Post-flood composition of the coral assemblage at Southwest Peel Island.

	Pre-flood	After flood	1981 Survey
Species number:	5	0	7
diversity (H)	0.15	0	0.12
evenness (J)	0.24	0	0.16
cover (%)	20.9	0	1.6
	Pre-flood	1981 survey	
Species component:			
<i>Favia speciosa</i>	×		×
<i>Goniopora lobata</i>	×		×
<i>Favites abdita</i>	×		×
<i>Turbinaria peltata</i>	×		×
<i>Cyphastrea serailia</i>	×		×
<i>Acanthastrea</i> sp.			×
<i>Favites halicora</i>			×

DISCUSSION

The results clearly show that the fringing reefs in Moreton Bay are highly modified by their bay environment but that their present nature is self-sustaining. The present distribution is best appreciated within four principle considerations: the bay's history; the range of coral assemblages; the flood effect; and evidence for recolonization.

HISTORY

A late Pleistocene fauna near the bay provides a basis for speculation as to an earlier coral presence. During the last glaciation (Wurm: c. 1.0×10^5 to 1.0×10^4 years B.P.) the bay existed as a landscape with the first direct evidence of reef development occurring in the Holocene. The distinctive reefs of that period developed to relatively recent times. A change in that fauna occurred in the form of a reduction of that assemblage. As

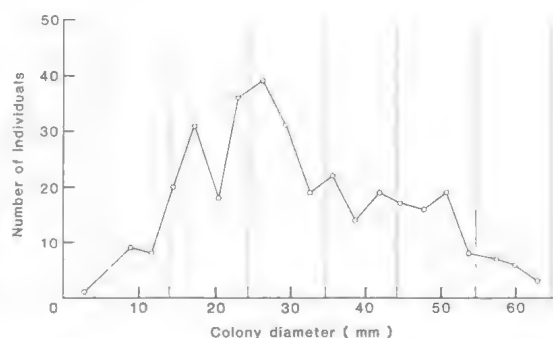


FIG 5. Size frequency distribution of *Favia speciosa* recruitment. Vertical lines show expected year class growth at 10 mm diameter per year. The period between the annual spawning and the sample date is 0.42 year. The vertical lines are positioned accordingly.

assemblage similar to the subfossil is extant at Flinders Reef, providing insight into the nature of the bay's paleoenvironment. The present distribution comprises those species tolerant to sedimentation and periodic dilution through flooding. The pre-flood description of this fauna and the subsequent differential flood mortality illustrate the most potent factors influencing the present distribution.

PRESENT REEF ASSEMBLAGES

The north side of Peel Island represents the diversity centre in the bay. Diversity is generally lower in the mainland sites and northern islands. Exceptions exist in those areas buffered by depth. The monospecific *Acropora* assemblage at Myora is unique and considered either a relic or the result of recent fortuitous immigration.

Comparing the sites' parameters of species diversity (H), evenness (J), species number and the percentage of living cover provides a fine scale description of the reefs and allows insight into the influences conditioning them (Table 3). Sites with a high diversity (H) are also characterized by high evenness ($r_s = 0.77$, Table 3a). They share similarities in the nature of their habitats. These are areas least affected by mainland influences. Those characterised by low index values are areas around the northern islands and the near mainland sites. A third group is represented by E Peel Island, the Myora 'coral patch' and E Bird and Goat Islands. They are thought to be principally limited by an unstable substrate.

The independence of sites from mainland influences is due to their distance (e.g. Peel, Bird and Goat Islands) or locations bayward of near

TABLE 3. Comparison of site diversity (H) with respect to, **a**, evenness ($J = H/H_{\max}$), **b**, species number and, **c**, percentage of living cover; **d**, comparison of number of species to the percentage of living cover. 'H' and 'L' denote high and low categories. The bracketed values quantify these categories. The Spearman Rank Correlation coefficient (r_s) compares the significance of the parameters considered. Comparisons of species number with evenness, and evenness with the percentage of living cover, were not significant.

a)		b)	
Diversity (H)		Diversity (H)	
	H (> 0.15)		L
Evenness	H (> 10%)	NE St Helena I. SE Green I. E Green I. SW' Peel I. SW Peel I. SE Peel I. NE Peel I. N Peel I. Submerged Peel I. NW Peel I. W Bird and Goat I. E Bird and Goat I.	SW Mud I. SE St Helena I. N St Helena I. W Green I. Cassim I. N Coochiemudlo I. W Peel I. E Peel I.
	L	SE Green I. SE Peel I.	SW Mud I. SW St Helena I. SE St Helena I. N St Helena I. W Green I. N Green I. King I. Raby Bay Cassim I. N Coochiemudlo I. NE Coochiemudlo I. W Peel I.
$r_s = 0.77$ Highly significant		$r_s = 0.69$ highly significant	
c)		d)	
Diversity (H)		Species Numbers	
	H (> 0.15)		L
% Living Cover	H (> 10%)	E Green I. SW' Peel I. SW Peel I. NE Peel I. N Peel I. Submerged Peel I. NW Peel I. W Bird and Goat I.	Cassim I. N Green I. SW St Helena I.
	L	NE St Helena I. E Peel I. SE Peel I. E Bird and Goat I. Myroa SE Green I.	SW Mud I. SE St Helena I. N St Helena I. W Green I. King I. Raby Bay Cassim I. N Coochiemudlo I. NE Coochiemudlo I. W Peel I.
$r_s = 0.35$ significant		$r_s = 0.57$ highly significant	

mainland islands (e.g. NE St Helena, E Green Islands). The eastern reef area on Green Island is relatively deep (3–4 m below MSL) and was the only northern island site to escape total destruction in the 1974 flood. The nearby NE assemblage at St Helena Island extends to this depth and has been characterized by its ocean-like environment on the basis of plankton samples (Greenwood, 1973). The buffering by depth in these areas during times of flood is inferred from the observed stratifications of freshwater during the 1974 flood and during the 1968 flood (Stephenson, 1968). Squires (1962) observed stratified runoff in Fiji where species presence was related to the distance from the Rewa River mouth.

With some exceptions, areas of low diversity are the result of an environment physically controlled by sporadic flood runoff. Distance from the mainland or occurrence in areas buffered by depth allow relatively more time for development towards a more diverse situation. In addition to the historical component, low index values reflect near mainland conditions where the immediate and persistent effects of silt make the area inhospitable to the development of coral assemblages. Bull (1982) in comparing two bays on Magnetic Island, North Queensland, found a marked reduction in species complement with the near absence of *Acropora* in the site most affected by siltation. Roy and Smith (1971) found a 50% lower coverage in turbid areas of the Fanning Island lagoon. Porter (1972a,b) attributed diversity reduction in back shelf regions of Caribbean reefs to sedimentation. Loya (1972) concluded that heavy sedimentation may be a very significant factor in determining scleractinian community structure. He attributed a reduction in species abundance and percentage cover in areas on Eilat Reefs to this agent. He points out that the few massive species found in this zone have probably evolved cleaning mechanisms. Marshall and Orr (1931), in studying the effects of sedimentation at Low Isles, Queensland found the predominant bay genus of *Favia* to be a very efficient sediment remover.

It is speculated that low diversity in areas unaffected by runoff (e.g. E and W Peel, E Bird and Goat Islands, Myora 'coral patch') are due to the unstable sandy substrate which is unsuitable for coral colonization. Motoda (1940) explained the paucity of reef corals in certain areas in Palau as due to favourable substances. Kissling (1965) found substrate to be the prime factor in regulating coral distributions in the shallow water environment at Spanish Harbour.

The high measure of evenness in low diversity situations relates to the overwhelming predominance of *Favia speciosa*. Sites grouped on the basis of evenness do not separate areas with any observed variable. Its independence of other parameters such as species number and percentage of living cover, indicates that the apportionment of the individuals among the species is not related to the physical factors presumed operative in conditioning the other measures.

In most sites an increase in species number represents a proportional increase in their relative abundances making the species number the best indication of diversity ($r_s = 0.69$, Table 3b). Areas of low diversity but high species number reflect a lack of physical stresses which prevent intolerant species from occurring. These sites are discussed with respect to unsuitable substrates. Areas of high diversity but low species number describe the situation where the species contribution to the index is low but their abundances are relatively equal. The sites do not share a common physical habitat but are characterized by low densities. It is uncertain as to the combination of factors which cause this. Areas of low diversity and species number invariably describe near mainland habitats where the species have been sorted by environmental stresses to those which are tolerant. The rarity of such species as *Coscinarea columna*, *Hydnophora exesa* and *Mycedium elephantotus* indicate that, to a very limited extent, recruitment of the bay corals may rely on communication with Flinders Reef where these corals are more abundant.

The relationship of diversity and species number to the percentage of living coverage are correlated with high significance ($r_s = 0.35, 0.57$, Table 3c,d respectively). Generally, relatively high diversity and species number were accompanied by appreciable coverage or were low with sparse coral occurrences. The groupings again separate the ocean-like sites from the near mainland areas. An exception to this relationship is the substrate limitation at W Peel Island. It is speculated that areas of limited coverage and high species numbers are due to a more predictable environment. Abundances here are reduced by unsuitable substrates.

Areas of low diversity, low species numbers and high coverage are typified by the predominance of *F. speciosa*. This species has utilized substrates unavailable to species intolerant of the flood-prone environment. Colonization here approaches the coverage characteristic of the more diverse areas. The 1974 flood caused complete mortality in these areas.

EFFECTS OF THE MAJOR FLOOD OF 1974

Between January 25 and February 1, 1974, torrential rainfall in the Brisbane Basin resulted in the greatest flood of this century. The influence of this condition on the bay coral was catastrophic.

Coral death was caused by intense rain during a cyclone coincident with a low tide that occurred on the Queensland coast in 1918 (Hedley, 1925a; Rainford, 1925). Slack-Smith (1959) recorded coral deaths at Peel Island in Moreton Bay due to rainfall. From Stoddart (1969), 'excessive water has killed shallow water biota by stream flooding in Jamaica' (Goodbody, 1961) and on the reefs in Tahiti (Crossland, 1928) and Samoa (Major, 1924). Endean *et al.* (1956) recorded similar destruction at Coral Point near Mackay, Queensland in 1951. Coral death at Low Isles following the flooding of the Daintree River in 1945 was investigated by Fairbridge and Teichert (1947, 1948).

The flood influence was principally confined to the western portion of the bay and islands. No mortality was observed on the northern margin of Peel Island or at the Myora 'coral patch'. The mechanism by which these areas escape destruction is due to bay circulation patterns. During times of flooding, there is pooling of undiluted seawater which remains as 'relic' or backwater on the northern side of the island (Stephenson, 1968).

Comparative salinities recorded by Kelley (unpublished) in the final two days of the 5-day flood period, allow comparison of the differential conditions experienced by the bay coral. In the northern area characterized by low diversities, he observed stratification of the freshwater, noting 10‰ salinity in the first metre near Mud Island. This increased to 15.5‰ in the second metre. St. Helena Island had salinities of 7.1‰ in the first metre, increasing to 13–15‰ in the second. In contrast, salinities on the north Peel Island reefs decreased to 21‰ in the first two metres and 24.6‰ by the sixth. The surface temperature at all sites and depths was relatively constant 23.6–26°C.

The results of laboratory work of Edmondson (1929) agree at the generic level with the 1974 post-flood observations. Of 23 species of Hawaiian corals introduced into seawater diluted by 50% with distilled water two bay genera *Favia* and *Psammocora* proved most hardy. They survived six days. These are the only corals which survived on the eastern reef of Green Island. All species died within a half hour of submergence in freshwater with the exception of *Favia hawaiiensis* which died after four hours. Of additional interest

is that two genera, *Pocillopora* and *Montipora* which occurred only in the subfossil as well as at Flinders Reefs, proved very intolerant to dilution, dying in 23 to 26 hours respectively, after dilution in the 50% solutions.

Comparison of reef diversities and percentage of living cover with the percentages of the 1974 flood mortality (Fig. 4), served to validate the hypothesis that diversity in Moreton Bay is physically controlled. Diversity is generally the result of the degree of immunity from periodic flooding. As large floods are relatively rare, the potential for higher diversity and percentage cover exists in reef areas more removed from the effects of river discharge.

RECOLONIZATION

Recruitment on a reef flat which experienced total flood mortality seven years previous, shows development consistent with aspects of its previous nature. The species complement is two species in excess of the pre-flood situation. The lower diversity and evenness are due to the predominance of *Favia speciosa* in the sample. Lower coral coverage reflects the juvenile nature of the assemblage.

Growth rate studies (Lovell, 1975a; Moore and Krishnaswami, 1973) enable the assessment of colony age from its diameter. A size frequency plot for *Favia speciosa* (Fig. 3) reveals a range of colony sizes indicating growth, beginning the season following the flood (November, 1974). Subsequent recruitment occurred every year until 1981. Variability in growth rate (\bar{X} = 5 mm; range 1.2 to 8.7 mm) makes it impossible to discern age classes and thus permits only a general appreciation of recruitment over the post-flood period. From the reproductive biology of similar faviids, it is assumed that the species has an annual spring spawning season (Kojis and Quinn, 1982; Babcock, 1984).

CHANGES IN THE NATURE OF THE BAY REEFS

Several hypotheses have been proposed to explain the change in the assemblage. Saville-Kent (1893) considered a general climatic change in temperature or in local elevation to be important. He believed that the islands of Stradbroke and Moreton were closing off the bay circulation, intensifying the effects of flooding from the Brisbane, Logan and Albert River systems. Wells (1955b) attributed the decline in development to a worsening of general conditions through a recent lowering of temperature (Hedley, 1925b; Howchin, 1924) and depth. A decrease in depth

of 2–4 m was deduced from species present in the subfossil which are found in deeper water in the Great Barrier Reef areas.

The proposition that circulation with oceanic waters has been reduced due to the passages north of Moreton Island and that north of Stradbroke Island has not been substantiated by comparative aerial photos (e.g. 40 yr time span) or present observations (Stephenson, pers. comm.). Shorelines at the culmination of the post-glacial transgression 6,000 years B.P., show slightly greater communication. Subsequent build-up of land about the bay and island perimeters has decreased the bay volume (Hekel *et al.*, 1979; Flood, 1978).

The lowering of sea temperature does not appear to be a principal factor in the reduction in the number of species. This conclusion is based on the large number of species present (112 spp) at Flinders Reef near Moreton Bay. With the exception of two species, all of the subfossil species are living in Flinders Reef. From the Solitary Islands off the New South Wales coast (30°S) there are 47 species representing a 59% co-occurrence with the subfossil record. Veron *et al.* (1974) note a temperature regime which is generally similar to Moreton Bay (Hedley, 1925b; Crohamhurst Conservatory, 1936; Greenwood, 1973). Information on sea temperature around Flinders Reef (CSIRO unpublished) indicates a similar regime to that of Moreton Bay and the Solitary Islands. Though temperatures between 14°C to 15°C have been recorded several times during detailed bay observations it is the author's opinion that deeper areas are immune to these extremes which represent surface records. Substantial tidal exchange between bay and oceanic waters aids in modifying the shallow water extremes resulting from local weather.

The differences between the environments and coral assemblages of the bay and Flinders Reef are evident today. The question remains, 'how similar was the Moreton Bay environment to that of Flinders Reef when a similar coral assemblage developed'? Species presence does not necessarily reflect the luxuriance or species abundance of the coral community. It is difficult to say whether the subfossil fauna living in the bay occurred as it now does at Flinders Reef. In terms of mass, the subfossil reefs would suggest this. Distinct from the recent, the subfossil and Flinders Reef assemblages are principally represented by elements of the Indo-Pacific province (Stehli and Wells, 1971).

With the transgression, reef development began occurring in shallow water. Why such develop-

ment was unaffected by terrestrial runoff and other mainland influences as siltation remains speculative. A change in climate from one with an equable rainfall to that of the present seasonal climate would affect the bay environment by increasing the potential sediment yield (Hekel *et al.*, 1979) and increase the runoff during the wet season.

The most evident temporal change in the bay environment was eustasy. Prior to 10,000 yrs B.P. the bay was a landscape. Subsequent filling with water allowed the Holocene reefal structures to begin development approximately 7,500 yrs B.P. (Flood, 1978). At 6,000 yrs B.P., the present mean sea level was reached (Thom and Chappell, 1975). Dated coral and beach rock indicates a high sea level between 1–2 m above present MSL (Jones *et al.*, 1978; Lovell, 1975b). It was during this eustatic high that the subfossil reefs developed. Such a substantial reef accretion could have only occurred in an environment of a more oceanic nature.

With eustatic decline, the reef assemblage became more vulnerable to the influences of the mainland on the bay environment. The effect of periodic flooding became more pronounced as the volume of the bay decreased. A change in direction of the Brisbane River outflow from a northerly to easterly direction gave the northern islands of Mud, St. Helena and Green, a nearshore nature with the encroachment of the river delta (Hekel *et al.*, 1979). This event does not constitute the principal reason for the change in the nature of the entire bay assemblage as Peel Island, representing a diversity centre, is relatively immune to this effect.

Faunal change may have been abrupt as the recent coral is observed growing on the subfossil facies. These facies, dated to recent times (Hekel *et al.*, 1979; Marshall, 1975) indicate that they have never been subjected to erosion from a marine regression. Reefal facies comprising only recent material are uncommon. The age of the recent assemblage has been estimated at 1,000–2,000 yrs B.P. (Hekel *et al.*, 1979). The possibility remains that the faunal change was much later.

Assessment of subsequent recolonization reflects the nature of the surviving species, in both complement and relative abundance. The attenuation of the subfossil species to those of the present is expected on the basis of species tolerance, given the presumed alteration of the bay environs. In areas of high diversity, lack of disturbance has resulted in longer periods for development. When local extinction occurs through flooding, the less flood prone areas represent a

component which will bias the composition of recolonization. The bay species differ in their physiological tolerances to this stress which serves as the mechanism in determining the assemblage.

The second factor is the presence of unsuitable substrate or the effect of silt suspension. The importance of silt as an inhibiting factor is uncertain. Observed were the limitation of reef areas by the presence of silt at the northern islands and near mainland sites, and the unconsolidated sandy areas on the eastern side of the bay.

CONCLUSIONS

1. The subfossil reefs occur more widely throughout the bay than the present living ones do. This older assemblage most likely occurred during a period when the bay was more oceanic in nature.
2. The reduction in the number of species in the bay has occurred during the period of eustatic decline. It is uncertain whether this was gradual or relatively abrupt.
3. This reduction is mainly the result of two circumstances:
 - a) The increased susceptibility of reef areas to the periodic effects of flooding.
 - b) The effects of siltation, turbidity and unsuitable substrate from terrestrial sedimentation.
4. The present day assemblage in the longer term, can survive a major flood. Circulation patterns allow the more diverse areas to remain relatively unaffected, providing a source of recruitment.
5. Recolonization of a flood devastated reef indicates that species number and, to a lesser extent, diversity are maintained.

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APPENDIX

Hermatypic Scleractinia of Moreton Bay (recent and subfossil)¹ and Flinders Reef².

	Moreton Bay 27.5°S		Flinders Reef 27.5°S		Moreton Bay 27.5°S		Flinders Reef 27.5°S
	Recent 18 species	Subfossil 26 species	112 species		Recent 18 species	Subfossil 26 species	112 species
Thamnasteriidae				<i>L. hemprichii</i>			+
<i>Psammocora contigua</i>	+	+	+	<i>Scolymia australis</i>			+
<i>P. digitata</i>			+	<i>S. cf. vitiensis</i>			+
<i>P. haimeana</i>			+	Pectiniidae			
Pocilloporidae				<i>Echinophyllia aspera</i>			+
<i>Pocillopora damicornis</i>		+	+	<i>Mycedium elephantotus</i>	+	+	+
<i>Seriatopora hystrix</i>			+	Caryophylliidae			
<i>Stylophora pistillata</i>		+	+	<i>Euphyllia ancora</i>			+
Faviidae				Dendrophylliidae			
<i>Favia fava</i>		+		<i>Heteropsammia cochlea</i>			+
<i>F. pallida</i>			+	<i>Turbinaria bifrons</i>			+
<i>F. maritima</i>			+	<i>T. frondens</i>	+	+	+
<i>F. speciosa</i>	+	+	+	<i>T. mesenterina</i>			+
<i>F. stelligera</i>	+	+		<i>T. patula</i>			+
<i>Favites abdita</i>	+	+	+	<i>T. peltata</i>	+	+	+
<i>F. chinensis</i>			+	<i>T. radicalis</i>			+
<i>F. flexuosa</i>			+	<i>T. stellulata</i>			+
<i>F. halicora</i>	+	+	+	Poritidae			
<i>F. pentagona</i>			+	<i>Alveopora allingi</i>			+
<i>F. russelli</i>			+	<i>A. marionensis</i>			+
<i>Goniastrea australiensis</i>			+	<i>A. spongiosa</i>			+
<i>G. favulus</i>			+	<i>Goniopora djiboutensis</i>			+
<i>G. pectinata</i>			+	<i>G. lobata</i>	+	+	+
<i>Platygyra daedalea</i>		+	+	<i>G. somaliensis</i>			+
<i>P. lamellina</i>	+	+	+	<i>G. stutchburyi</i>	+	+	+
<i>P. sinensis</i>			+	<i>Porites australiensis</i>			+
<i>Leptoria phrygia</i>			+	<i>P. lobata</i>			+
<i>Hydnophora exesa</i>	+	+	+	<i>P. lutea</i>			+
<i>H. microconos</i>			+	<i>P. murrayensis</i>			+
<i>Montastrea annuligera</i>			+	Acroporidae			
<i>M. curta</i>			+	<i>Acropora austra</i>			+
<i>M. magnistellata</i>			+	<i>A. clathrata</i>			+
<i>Plesiastrea versipora</i>	+	+	+	<i>A. cytherea</i>			+
<i>Leptastrea bewickensis</i>			+	<i>A. danai</i>			+
<i>L. transversa</i>			+	<i>A. divaricata</i>			+
<i>Cyphastrea serialia</i>	+	+	+	<i>A. digitifera</i>	+	+	
Agariciidae				<i>A. donei</i>			+
<i>Pavona explanulata</i>			+	<i>A. florida</i>			+
<i>P. maldivensis</i>			+	<i>A. gemmifera</i>			+
<i>P. minuta</i>			+	<i>A. glauca</i>			+
<i>P. varians</i>			+	<i>A. grandis</i>			+
Siderastreidae				<i>A. humilis</i>			+
<i>Coscinaraea columna</i>	+	+	+	<i>A. hyacinthus</i>		+	+
Fungiidae				<i>A. latistella</i>			+
<i>Cycloseris costulata</i>	+		+	<i>A. lutkeni</i>			+
Mussidae				<i>A. microclados</i>			+
<i>Acanthastrea bowerbanki</i>			+	<i>A. millepora</i>			+
<i>A. echinata</i>			+	<i>A. nana</i>			+
<i>A. hillae</i>		+	+	<i>A. nasuta</i>		+	+
<i>A. lordhowensis</i>			+	<i>A. nobilis</i>			+
<i>Lobophyllia corymbosa</i>	+	+	+	<i>A. palifera</i>			+

APPENDIX cont.

	Moreton Bay 27.5°S		Flinders Reef 27.5°S		Moreton Bay 27.5°S		Flinders Reef 27.5°S
	Recent 18 species	Subfossil 26 species	112 species		Recent 18 species	Subfossil 26 species	112 species
<i>A. palmerae</i>			+	<i>A. moretonensis</i>		+	+
<i>A. robusta</i>			+	<i>A. myriophthalma</i>			+
<i>A. samoensis</i>			+	<i>Montipora caliculata</i>			+
<i>A. sarmentosa</i>			+	<i>M. danae</i>			+
<i>A. secale</i>			+	<i>M. foveolata</i>			+
<i>A. solitaryensis</i>			+	<i>M. mollis</i>		+	+
<i>A. subulata</i>			+	<i>M. peltiformis</i>			+
<i>A. valida</i>		+	+	<i>M. spongodes</i>			+
<i>A. verweyi</i>			+	<i>M. spumosa</i>			+
<i>A. yongei</i>			+	<i>M. tuberculosa</i>			+
<i>Astreopora cucullata</i>			+	<i>M. turtlensis</i>			+
<i>A. listeri</i>			+	<i>M. venosa</i>			+

¹An early version of this was published in Lovell (1975b). The taxonomy now conforms to Veron *et al.* (1976–1984); Flinders Reef species list was compiled jointly with Dr Veron.

²Wells (1955a). The taxonomy now conforms to Veron *et al.* (1976–1984).

A REVISION OF THE SILLAGINID FISHES OF THE ARABIAN GULF WITH A DESCRIPTION OF *SILLAGO ARABICA* NEW SPECIES.

ROLAND J. MCKAY AND LINDA J. MCCARTHY

McKay, R.J. and McCarthy, L.J. 1989 11 13: A revision of the sillaginid fishes of the Arabian Gulf with a description of *Sillago arabica* new species. *Mem. Qd Mus* 27(2): 551-553. Brisbane. ISSN 0079-8835.

Three species of sillaginid fishes are known from the Arabian Gulf, *Sillago sihama*, *Sillago attenuata*, and *Sillago arabica* sp. nov.
□ *Pisces*, *Sillaginidae*, *whiting*, *Arabian Gulf*.

Roland J. McKay, *Queensland Museum, PO Box 300, South Brisbane, Queensland 4101, Australia*; Linda J. McCarthy, *1104 Kriss Lane, Jupiter, Florida 33458, U.S.A.*; 8 August, 1988.

McKay (1985) revised the fishes of the family Sillaginidae and recorded two species from the Arabian Gulf: *Sillago sihama* (Forsskål, 1775) and *Sillago attenuata* McKay, 1985. The former species was represented by 3 specimens, which were listed as 'probably related to *S. sihama*'; the swimbladder was not studied. Recent collecting by the second author and her husband, Brock E. Stanaland, in the Arabian Gulf, resulted in a number of sillaginid fishes being taken by seine net. The second author identified the material as belonging to three species, *S. sihama*, *S. attenuata* and a small new species described here as *Sillago arabica*. In this paper, acronyms and abbreviations follow McKay (1985).

KEY TO THE SILLAGINID FISHES OF THE ARABIAN GULF

1. Dorsal spines 11; lateral scales 65-72; swimbladder with two forwardly projecting anterior extensions, a short anterolateral extension with

a long convoluted tubule extending posteriorly along abdominal wall to level of ventral duct-like process, and two posterior extensions projecting into caudal region; vertebrae 34
.....*Sillago sihama*
Dorsal spines 12-13 (rarely 11); lateral line scales 74-80; swimbladder without anterior extensions and with a short single posterior extension; vertebrae 37-40 2

2. Dorsal fin rays 19-21; anal fin rays 18-20; sides of body with two to three series of dark blotches; snout long, 38-41 percent of head length; vertebrae 15+2+20-21, total 37-39 ..
.....*Sillago attenuata*

Dorsal fin rays 22-24; anal fin rays 22-24; body uniform pale, without dark blotches; snout short, 31-38 percent of head length; vertebrae 15-16+0-1+21-24, total 38-40
..... *Sillago arabica*

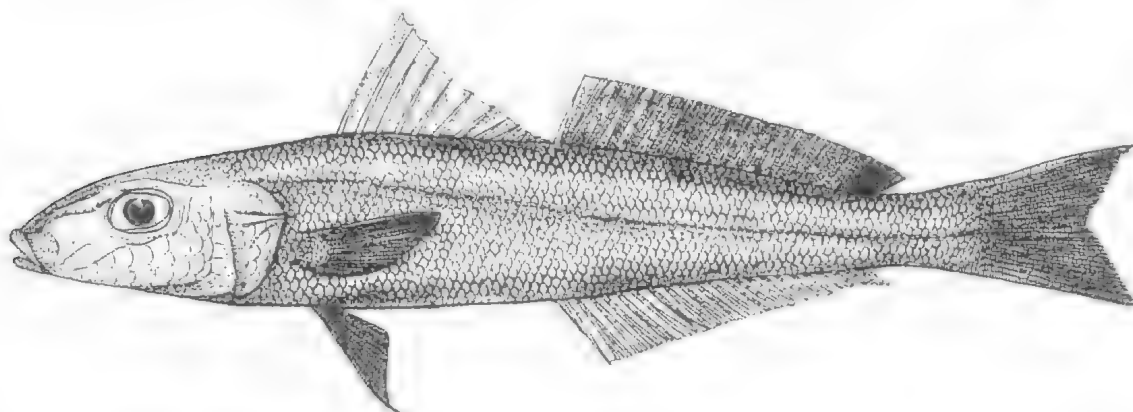


FIG. 1. Holotype of *Sillago arabica* sp. nov.

***Sillago (Parasillago) arabica* new species**
Shortnose Whiting
(Fig. 1, 2A, 3A-C)

MATERIAL EXAMINED

HOLOTYPE: SL 98 mm, collected by L. Stanaland, October 1982, at Tanajib Bay, Arabian Gulf, 27°50'N; 48°52'E, I.21736.

PARATYPES: Arabian Gulf collected by L. Stanaland, Tanajib Bay, (SL 84-115 mm) 1. 21765 (4) 5.X.1982, 1.22670 (1) 17.VI.1984, 1.22671 (11) 5.X.1985; Manifa Bay, 1.22669 (25) 13.X.1984, 1.22672 (13) 6.VIII.1985, 1.22673 (6), 1.22674 (1), 6.X.1985, BPBM 31806 (1), BM 1987.6.30.6 (1); MNHN 1987-1098 (1), RUSI 26877 (1), AMNH 48676 (1), USNM 288497 (1).

DIAGNOSIS

Dorsal fins XII-XIII, 1, 22-24; anal fin 11, 22-24, lateral line scales 75-80. Swimbladder without anterior extensions and with a single posterior extension. Vertebrae 15-16 abdominal, 22-25 caudal, total 38-40.

DESCRIPTION

(Holotype and 67 paratypes) dorsal fins XII (56) XIII (10), 1, 22-24; anal fin II, 22-24. Lateral line scales 75-80. TR 5-6 above, 11-12 below, 5 scales between L. lat. and spinous dorsal fin. Cheek scales in 3-4 rows, all ctenoid.

Proportional dimensions as percent of SL (68 paratypes): Greatest depth of body 16-20; head length 24-29; snout tip to second dorsal fin origin 52-56; snout tip to anal fin origin 53-59; least depth of caudal peduncle 7-8. Proportional dimensions as percent of head length: length of snout 31-38 (mostly 33-35); horizontal diameter of eye 22-29; least width of interorbital 17-20.

VERTEBRAE: (Dissected, stained and cleared) 15-16 + 0-1 + 21-24, 15-16 abdominal, 22-25 caudal, total 38-40 (21 paratypes).

COLOUR IN ALCOHOL: (Holotype) head and body pale sandy brown, slightly paler on mid-line of belly; mid-lateral band indistinct; upper part of opercle slightly dusky in the centre; spinous dorsal, second dorsal, and caudal fins lightly dusted with black, other fins hyaline.

SWIMBLADDER: Anterior margin truncate or slightly rounded without anterior extensions; a single short posterior extension; a duct-like tubular process from ventral surface to urogenital aperture (Fig. 2A).

DISTRIBUTION

Arabian Gulf.

BIOLOGY

Sillago arabica is an inshore species captured by

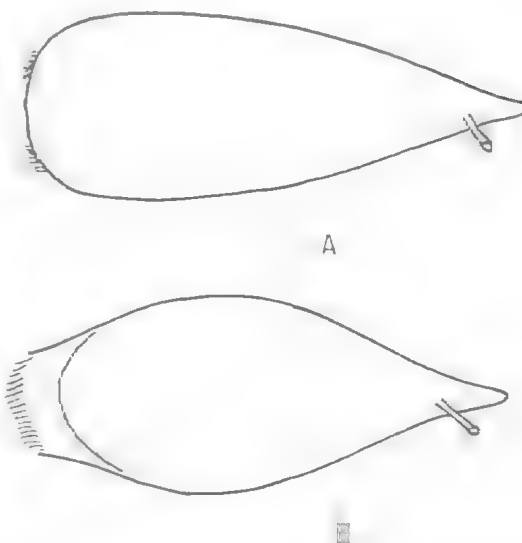


FIG. 2. Swimbladders: A. *Sillago arabica* sp. nov. B. *S. attenuata*.

beach seine. Salinities taken at collecting sites were 46‰-48‰, and water temperatures varied from 27.7°C to 33.1°C.

REMARKS

In McKay (1985: 14, couplet 9), this new species keys to those having a total vertebrae count of 37-39 (now 37-40) and includes *Sillago boutani*, *S. schomburgkii* and *S. attenuata*. From *S. boutani* it differs in having 15 to 16 abdominal vertebrae instead of 13 to 14, one or no modified vertebrae instead of 3 to 4, and 22 to 24 rays in the second dorsal and anal fins instead of 21 and 21 to 22 respectively in *S. boutani*. From *S. schomburgkii* it differs in having 22 to 24 dorsal rays instead of 20 to 22, and 22 to 24 anal rays instead of 17 to 20, the snout is shorter (31 to 38% vs 39 to 44% head length), and the latter species has 8 to 11 modified vertebrae overlying the longer post-coelomic extension to the swimbladder.

***Sillago (Parasillago) attenuata* McKay**
Slender Whiting
(Fig. 2B, 3D)

Sillago (Parasillago) attenuata McKay, 1985, p. 36 (Arabian Gulf).

MATERIAL EXAMINED

In addition to specimens mentioned by McKay (1985), Arabian Gulf (4) collected by L. Stanaland; Tanajib Bay,

I.22663, 5.X.1985; I.22665, 22.II.1984; I.22666, 29.XII.1985; Manifa Bay, I.21762, 18.IV.1984.

DIAGNOSIS

Dorsal fins XI-XIII (mostly XII), 1, 19-21; anal fin 11, 18-20; lateral line scales 73-77. Vertebrae 15 abdominal, 22-23 caudal, total 37-39. Body with faint to quite distinct dark blotches in three series laterally; the upper row of 12 short black lines at dorsal mid-line near base of fins; middle row of 7-9 spots on upper back; a mid lateral row of 10-11 elongate black blotches below lateral line; snout with two dark longitudinal lines converging anteriorly in some examples.

DESCRIPTION

See McKay (1985: 36).

SWIMBLADDER: Almost transparent in juveniles; an elongate somewhat oval-shaped bladder, rounded anteriorly and tapering to a short single posterior extension; a short tubular duct-like process from ventral surface to urogenital aperture (Fig. 2B).

Sillago (Sillago) sihama (Forsskal) Sand Smelt (Fig. 3E-J)

Atherina sihama Forsskal, 1775, p. 70 (Red Sea).

MATERIAL EXAMINED

Ras Tanura, Tarut Bay, upper bay Zaal Island, April-June, 1948, USNM 14759 (10); Ras Tanura, American City Beach on Gulf side, June 1948, collected Erdman, USNM 147960 (3); Manifa Bay, 13.X.1984, I.22667 (5); Tanajib Bay, 17.VI.1984, collected L. Stanaland, I.21764 (1).

DIAGNOSIS

Dorsal fins XI, 1, 20-23; anal fin II, 21-24, lateral line scales 65-69. Vertebrae 34. Swimbladder with two median anterior extensions terminating each side of auditory capsule; a pair of anterolateral extensions, each sending a blind tubule towards upper part of gill opening and then recurving posteriorly to lie alongside swimbladder to about level of ventral duct; two posterior extensions projecting well into caudal region (Fig. 1).

DESCRIPTION

See McKay (1985: 9).

GEOGRAPHIC VARIATION

Dissected material had 13 abdominal vertebrae instead of 14 as recorded by McKay (1985). Counts

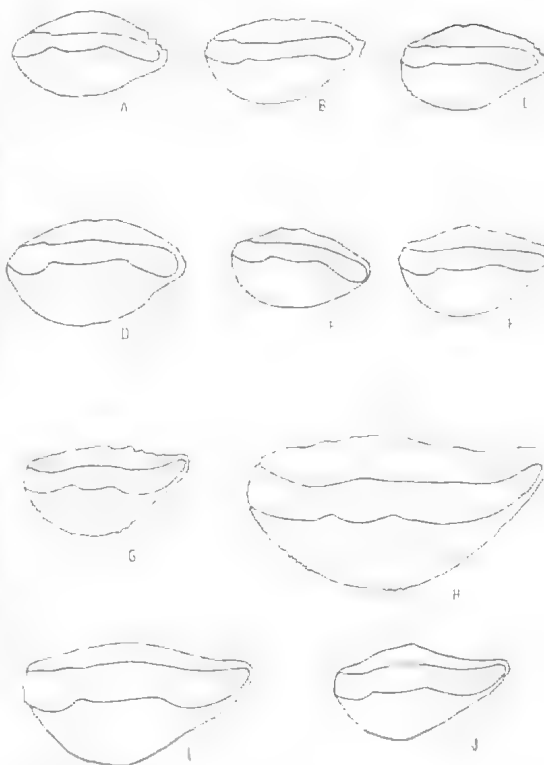


FIG. 3. Right otoliths: A-C, *Sillago arabica* sp. nov. D, *S. attenuata*. E-F, *S. sihama*, Arabian Gulf. G, H, *S. sihama*, Cochin, India. I, *S. sihama*, Denpasar, Indonesia. J, *S. sihama*, Proserpine, Queensland.

were 13 + 6 + 15 (3) and 13 + 7 + 14 (1). The otolith of two specimens from the Arabian Gulf differs from the more usual shape in having the posterior tip more rounded, and the cauda is directed more downwards (Fig. 3E, F). This variation indicates that the Arabian Gulf population is genetically isolated.

ACKNOWLEDGEMENTS

We wish to record our appreciation of the efforts of Brock E. Stanaland who hauled the deeper end of the seine net. Our sincere thanks to Drs P. Jell and G. Ingram for reading the manuscript.

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TWO NEW SPECIES OF THE FRESHWATER CRAYFISH *EUASTACUS* CLARK
(DECAPODA: PARASTACIDAE) FROM ISOLATED HIGH COUNTRY OF QUEENSLAND

GARY J. MORGAN

Morgan, G.J. 1989 11 13: Two new species of the freshwater crayfish *Euastacus* Clark (Decapoda: Parastacidae) from isolated high country of Queensland. *Mem. Qd Mus.* 27(2): 555-562. ISSN 0079-8835.

Two new species of *Euastacus*, *E. bindal* and *E. monteithorum* are described from Queensland. Both are morphologically similar to *E. eungella* but differ in spination of the carapace and chelae and in the shape of the sternal keel. The species inhabit streams in isolated pockets of elevated rainforest on Mt Elliot and Krombit Tops. A key to Queensland *Euastacus* species is modified to incorporate these species. Biogeographic affinities of *Euastacus* and the frog genus *Taudactylus* are discussed.

□ Crustacea, Parastacidae, *Euastacus*, Queensland.

Gary J. Morgan, Western Australian Museum, Francis Street, Perth, Western Australia 6000, Australia; 23 November, 1988.

Freshwater crayfish of the genus *Euastacus* Clark occurring in Queensland have been discussed in several taxonomic studies including Watson (1935, 1936), Clark (1936, 1941), Riek (1951, 1956, 1969), Monroe (1977) and Morgan (1988). Subsequent to the extensive collection undertaken by Morgan (1988), several specimens of *Euastacus* were collected from two previously unsampled highland localities in Queensland. Examination of the specimens revealed them to be representatives of two undescribed species.

Methods, terminology and abbreviations employed here are those described by Morgan (1986, 1988). Collection localities are indicated in Figure 1.

***Euastacus bindal* sp. nov.**
(Fig. 2)

MATERIAL EXAMINED

HOLOTYPE: ♀, OCL 24.9 mm, upper North Creek, Mt Elliot, (19°30'S, 146°58'E), NEQ, 1000 m, rainforest, 2-5 December 1986, coll. Monteith, Thompson and Hamlet, QM W15582.

PARATYPE: ♂, OCL 17.7 mm, type locality, QM W15582.

DIAGNOSIS

Similar to *E. eungella* Morgan, but differing in having numerous blunt spines lateral to dactylar articulation of chelipeds on both dorsal and ventral surfaces, spines distributed some distance distally along fixed finger; dorsal carpal spines absent; 4th mesial carpal spine well developed and subequal to 3rd spine; rostral spines larger; sternal keel between Pr3 and Pr4 blunt and not produced in a sharp carina.

DESCRIPTION

Rostrum: Short, reaching base of 3rd antennal segment. Rostral margins parallel or slightly divergent; carinal bases short and divergent. 2 medium-sized, moderately acute marginal spines per side, distributed slightly proximal to midlength of carinae. Acumen spine slightly larger than marginal spines. OCL/CL 0.86-0.87. RW/OCL 0.14-0.16.

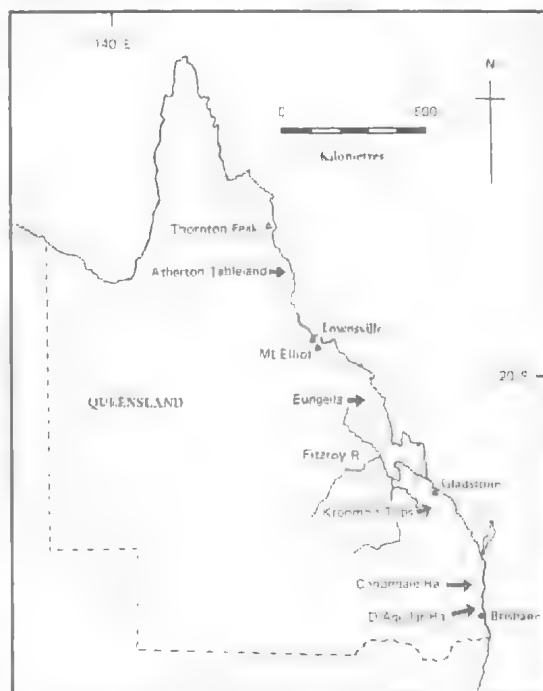


FIG. 1. Type localities of *E. bindal* (Mt Elliot) and *E. monteithorum* (Krombit Tops), with other localities mentioned in text.

Cephalon: Weakly spinose. 1st postorbital spine medium-sized or small; 2nd postorbital spine absent. Suborbital spine medium-sized. Antennal squame with lateral margin distinctly concave, lacking spines, squame widest approximately at midlength. Epistome (interantennal spine) moderately elongate with weakly scalloped margins. Antennal basipodite spine absent; coxopodite spine weakly developed. ScL/OCL 0.15-0.16.

Thorax: Dorsal spines absent. Thoracic tubercles small and densely distributed on holotype, very small and sparser on paratype. Cervical spines weakly developed. ArL/OCL 0.38-0.39. ArW/OCL 0.17-0.18. CaW/OCL 0.51-0.52. CaD/OCL 0.45-0.48.

Abdomen: Abdominal spines absent except for 4-5 small blunt Li spines on somite 2 of holotype, absent on paratype. Dorsal boss absent. AbdW/OCL 0.48-0.49. OCL/L 0.40-0.41.

Tailfan: Dorsal telsonic spines absent, surface roughened. Distolateral spines medium-sized. TeL/OCL 0.33-0.34.

Chelipeds: Chelae moderately stout (regenerate right cheliped of holotype elongate).

Dactyl: 6 spines dorsal to cutting edge, distributed along full length of gape, spines medium-sized to large (largest proximally) and moderately acute. 1 additional distodorsal spine on dactyl of non-regenerate chela of holotype. Mesial basal spines absent; 2 mesial apical spines. Dactylar groove deep. DactL/PropL 0.49-0.52.

Propodus: 2 lateral spine rows, ventral row reaching to or proximal to midlength of propodus; spines medium-sized and broadly triangular with small corneous tips. 6 mesial spines on palm (including rather blunt spine at distal angle). Holotype with 4 and paratype with 2-3 dorsal apical spines on non-regenerate chelae, (2 spines on regenerate chela of holotype), spines forming longitudinal row along fixed finger and almost reaching spines lateral to dactylar articulation. 4-6 medium-sized to large (largest proximally) spines dorsal to cutting edge, spines distributed in row along entire gape. Dorsal and ventral surfaces of palm and proximal part of fixed finger with numerous blunt spines and tubercles lateral to dactylar articulation, spines distributed some distance along fixed finger. No spines proximal to dactylar articulation. PropL/OCL 0.90-0.97. PropW/PropL 0.44-0.47. PropD/PropL 0.31-0.32.

Carpus: Deep dorsolongitudinal groove. 4 mesial spines, distalmost (1st) largest and strongly offset ventrally to others; 4th spine subequal to or only slightly smaller than 3rd spine (much smaller

than 3rd on regenerate chela of holotype). Lateral spines weakly developed or absent. Dorsal spines absent. Ventral spine medium-sized and much larger than 3-5 small blunt ventromesial spines.

Merus: 7-8 small dorsal spines, distal 2 similarly sized to others. Distolateral spine minute or absent.

Keel: Pr1 with posterior margin sloped; processes close and parallel. Pr2 approximately parallel and apart. Pr3 with posterior edges rather rounded. Pr4 with anterior edges angular, posterior edges sharp and convex. Keel lacking spines, only bluntly carinate between Pr3 and Pr4.

Setation: Moderate on holotype, light on paratype; setae short.

Punctuation: Rather dense on cephalon and thorax.

Gastric mill: TAP count 3.5, TAA count 1.0, spread 2.5. Urocardiac ridges 5; urocardiac ossicle shallow.

Coloration: No live colour notes available.

Sexes: Male paratype with cuticle partition. Female holotype with deeply incised gonopores very lightly fringed with setae, implying imminent onset of maturity.

DISTRIBUTION

The species is known only from Mt Elliot, NEQ. (Fig. 1).

HABITAT

The type locality is near the peak of Mt Elliot, at an elevation of about 1000 m. Rainforest flanks the headwaters and tributaries of North Creek.

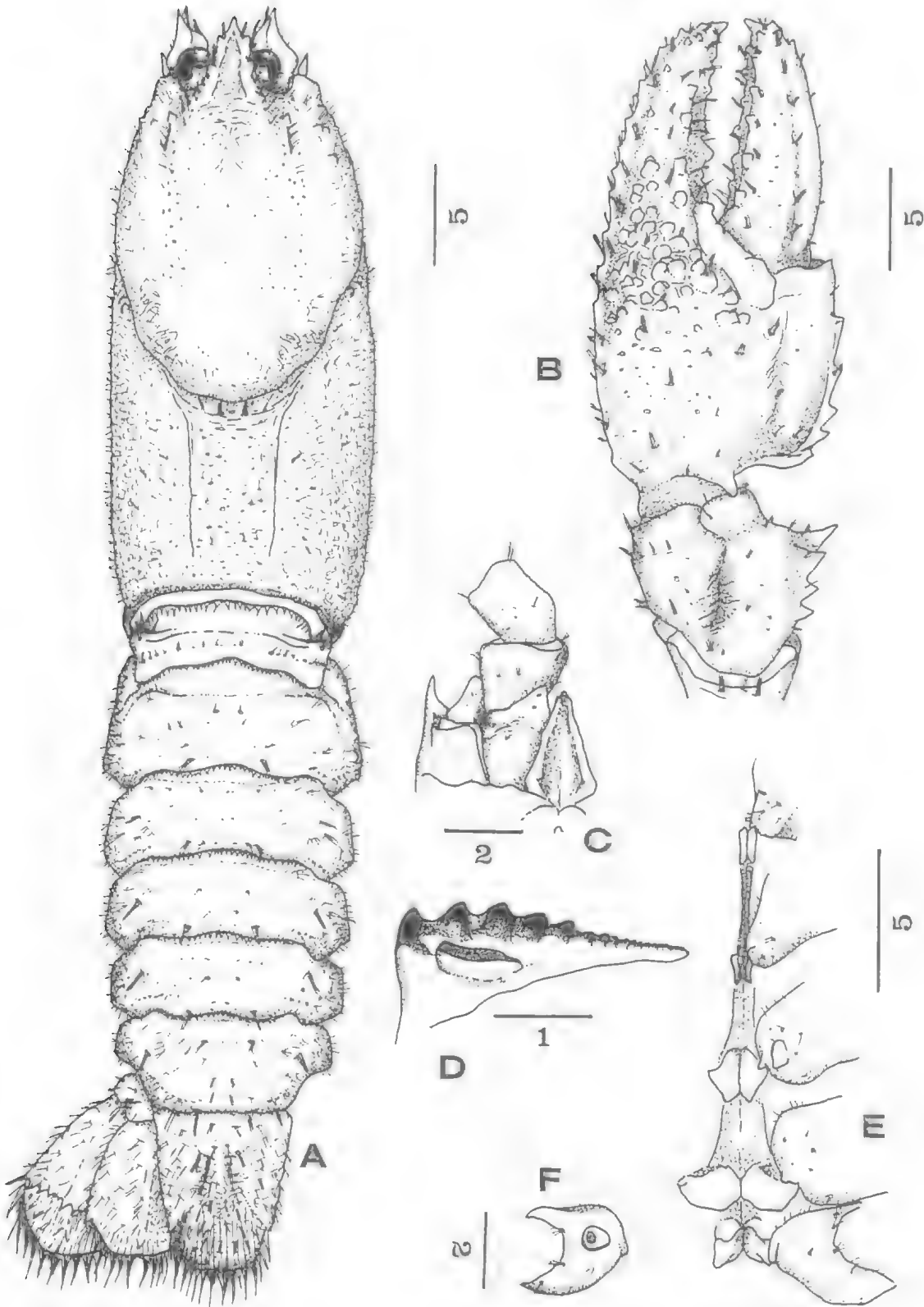
ETYMOLOGY

The species is named after the Bindal aboriginal language of the Mt Elliot area (Oates and Oates, 1970).

REMARKS

The discovery of populations of *Euastacus* on Mt Elliot is not surprising. On a previous collecting trip in 1981, attempts to find specimens there were unsuccessful although the habitat on and near the peak appeared suitable for the crayfish (pers. obs.) with fast flowing cool streams and fringing rainforest.

FIG. 2. *Euastacus bindal*. A-E, holotype ♀, F, paratype ♂. A, cephalothorax, abdomen and tailfan, dorsal view; B, dactyl, propodus and carpus of left cheliped, dorsal view; C, epistome and basal segments of antenna, ventral view; D, zygocardiac ossicle of gastric mill, lateral view; E, sternal keel; F, coxa of fifth pereopod of ♂. Scales in mm.



E. bindal closely resembles *E. eungella* of the Clarke Range, 240 km to the southeast. The species differ most distinctly in ornamentation of the chelipeds.

***Euastacus monteithorum* sp. nov**
(Fig. 3)

MATERIAL EXAMINED

HOLOTYPE: Male, OCL 37.9 mm, 'Beauty Spot 98' (Queensland Department of Forestry), headwaters of Kroombit Creek, Kroombit Tops, (24°22'S, 151°00'E), central Q., 860 m, rainforest, 29 September 1985, coll. G.B. and S.R. Monteith, QM W15583.

DIAGNOSIS

Similar to *E. eungella*, but differing in lacking first postorbital ridge spines; lacking dorsal carpal spines on chelae; keel Pr1 apart and anteriorly convergent and keel between Pr3 and Pr4 very pronounced anteriorly; setation much heavier on thorax and abdomen.

DESCRIPTION

Rostrum: Shorter than base of 3rd antennal segment. Rostral margins slightly divergent; carinal bases short and divergent. 2 medium-sized, moderately acute spines per side, apical or distributed to midlength of carinae. Acumen spine slightly larger than marginal spines. OCL/CL 0.88. RW/OCL 0.13.

Cephalon: Weakly spinose. Postorbital spines absent. Suborbital spine medium-large. Antennal squame with lateral margin straight, lacking spines, squame widest slightly distal to midlength. Epistome moderately elongate with weakly scalloped margins. Antennal basipodite spine absent; coxopodite spine medium-sized. ScL/OCL 0.13.

Thorax: Dorsal spines absent. Thoracic tubercles small and densely distributed. 4 small rounded cervical spines. ArL/OCL 0.40. ArW/OCL 0.18. CaW/OCL 0.54. CaD/OCL 0.45.

Abdomen: 2-4 small, sharp or moderately acute Li spines on somite 2; other somites unarmed except for minute setal bumps in Lii position. Dorsal boss absent. AbdW/OCL 0.46. OCL/L 0.42.

Tailfan: Dorsal telsonic spines absent, surface roughened. Distolateral spines small to medium-sized. TeL/OCL 0.31.

Chelipeds: Chelae elongate (left larger than right but both probably regenerate; proportions cited for left chela).

Dactyl: 5 spines dorsal to cutting edge of larger

left chela, 1 on small right chela, distributed proximal to midlength of gape; spines medium-sized, largest distally, and moderately acute. Mesial basal spines absent on left chela, 1 ventromesial basal spine on small right chela; 2 mesial apical spines. Dactylar groove inconspicuous. DactL/PropL 0.57.

Propodus: 2 lateral spine rows, ventral row reaching slightly proximal to midlength of propodus; spines medium-sized and sharp. 5 mesial spines on palm. Larger chela with 3 dorsal apical spines, small regenerate chela lacking spines. 4 medium-sized, moderately acute spines dorsal to cutting edge on larger chela, distributed proximal to midlength of gape; 1 apical spine only on small chela. Dorsal and ventral surfaces of palm almost smooth lateral to dactylar articulation except for 1 small dorsal and ventral spine and some slight rugosities on large chela, small chela lacking spines. No spines proximal to dactylar articulation. PropL/OCL 0.93. PropW/PropL 0.40. PropD/PropL 0.25.

Carpus: Deep dorsolongitudinal groove. 3 mesial spines, and one proximal tubercle on larger cheliped; distalmost (1st) spine much the largest and only slightly offset ventrally to others. 2 minute lateral spines. Dorsal spines absent. Ventral spine medium-sized and larger than small blunt ventromesial spines.

Merus: About 7 dorsal spines, medium-sized to small. Distolateral spine absent.

Keel: Pr1 with posterior margin semi-abrupt; processes apart and convergent anteriorly. Pr2 almost parallel and apart. Pr3 with sharp posterior edges. Pr4 with moderately angular anterior edges and convex, rather sharp posterior edges. Keel lacking spines but slightly produced posterior to Pr2 and strongly produced posterior to Pr3.

Setation: Moderately heavy, setae short.

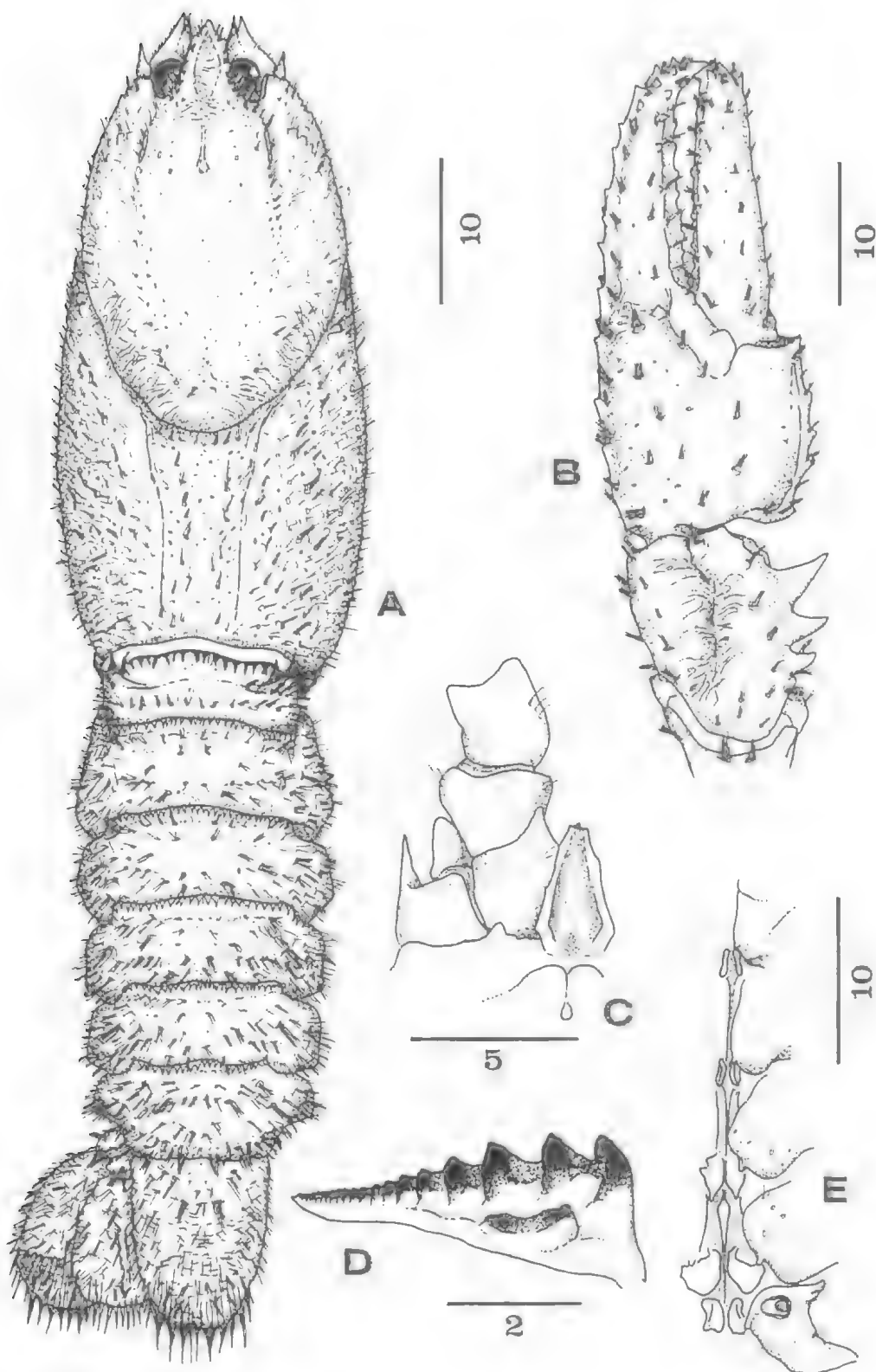
Punctuation: Moderately dense on cephalon, dense on thorax.

Gastric mill: TAP count 3.0, TAA count 1.0, spread 2.0, Urocardiac ridges 6; urocardiac ossicle shallow.

Coloration: No live colour notes available.

Sexes: Male with broad cuticle partition.

FIG. 3. *Euastacus monteithorum*. Holotype ♂. A, cephalothorax, abdomen and tailfan, dorsal view; B, dactyl, propodus and carpus of left cheliped, dorsal view; C, epistome and basal segments of antenna, ventral view; D, zygocardiac ossicle of gastric mill, lateral view; E, sternal keel. Scales in mm.



DISTRIBUTION

The species is known only from Kroombit Tops, CQ (Fig. 1).

HABITAT

The type locality, designated 'Beauty Spot 98' by the Queensland Forestry Department, is on the headwaters of Kroombit Creek and fringed with rainforest (Monteith, 1986). Altitude is approximately 860 m. General data on the habitats of Kroombit Tops were recorded by Monteith (1986) and McDonald and Sharpe (1986).

ETYMOLOGY

The species is named after its collectors, Geoff and Sybil Monteith.

REMARKS

E. monteithorum resembles *E. eungella* and *E. bindal* but differs in its lack of a 1st postorbital spine and in having the keel Pr1 apart rather than adjacent. It also differs from *E. bindal* in having the surfaces of the palms of chelipeds lateral to the dactylar articulation almost smooth and from *E. eungella* in lacking dorsal carpal spines.

KEY

Morgan (1988) presented a key to the Queensland species of *Euastacus*. The following modification will permit incorporation of the new species into that key:

- In couplet 6, the entry of '*E. eungella*' is replaced by '12' which is appended to the key.
- 12 (6). 1st postorbital spine absent; dorsal carpal spines absent; keel Pr1 apart and slightly convergent anteriorly *E. monteithorum*
1st postorbital spine present; dorsal carpal spines present or absent; keel Pr1 close and parallel 13
- 13 (12). Numerous blunt spines on dorsal and ventral surfaces of propodus lateral to dactylar articulation, distributed some distance along fixed finger; dorsal carpal spines absent; 4th (proximal) mesial carpal spine subequal to or only slightly smaller than 3rd spine *E. bindal*
1 or 2 small or medium-sized spines on dorsal and ventral surfaces of propodus

lateral to dactylar articulation, sometimes with some minute lateral bumps or rugosities dorsally but smooth ventrally, spines not distributed along fixed finger; dorsal carpal spines present; 4th mesial carpal spine absent or if present much smaller than 3rd spine *E. eungella*

DISCUSSION

The description of these species brings to 14 the total known species of *Euastacus* in Queensland. Both were collected from elevated, relatively remote areas accessed only with some difficulty, with isolated stands of rainforest. The habitats of the localities, although not recorded in great detail, agree with the general appraisal of *Euastacus* habitats recorded by Morgan (1988).

Both *E. bindal* and *E. monteithorum* show closest morphological affinities with *E. eungella*. Mt Elliot is approximately 240 km northwest of the Eungella-Clarke Range habitat of *E. eungella*. The intervening country is mostly of low elevation, with few areas exceeding 800 m, and mountain rainforest is rare. Suitable habitat for *Euastacus* is unlikely to exist today between these localities. Mt Elliot is separated by about 250 km from the Bellenden Ker region to the north, inhabited by *E. balanensis* Morgan. The intervening country has some high altitude areas with mountain rainforest (e.g. Mt Spec, Cardwell Range) but previous collection in these areas did not yield specimens of *Euastacus*. Similarly, Kroombit Tops lies about 425 km southeast of the Clarke Range and is separated by low relief. A further 280 km of relatively low country then separates Kroombit Tops from the Conondale Range area, home of *E. hystriocosus* Riek and possibly *E. urospinosus* (Riek).

The ecological isolation of their known ranges supports the recognition of the two morphotaxa as biological species. These distributions confirm the relict population theory proposed by Morgan (1988). North of southeastern Queensland, *Euastacus* species are confined to relatively small, elevated areas of rainforest, with the associated cold, fast flowing streams. It is interesting to compare this distribution with that of other montane species.

In particular, a nearly parallel distribution is displayed by the myobatrachid frog genus, *Tau-dactylus*. These frogs are found exclusively associated with streams in elevated (above 300 m) areas of rainforest in eastern Queensland (Liem and Hosmer, 1973; Ingram, 1980; Czechura, 1986).

TABLE 1. Distributions of species of *Taudactylus* and sympatric *Euastacus* in Queensland.

Locality	<i>Taudactylus</i>	<i>Euastacus</i>
Thornton Peak, Mt Lewis, Atherton Tableland	<i>T. rheophilus</i> Liem and Hosmer <i>T. acutirostris</i> (Andersson)	<i>E. robertsi</i> Monroe <i>E. fleckeri</i> (Watson) <i>E. balanensis</i> Morgan
Mt Elliot	—	<i>E. hindal</i> sp. nov.
Clarke Range, Eungella	<i>T. liemi</i> Ingram <i>T. eungellensis</i> Liem and Hosmer	<i>E. eungella</i> Morgan
Kroombit Tops	<i>T. pleione</i> Czechura	<i>E. monteithorum</i> sp. nov.
Blackall, Conondale, D'Aguilar Ranges	<i>T. diurnis</i> Straughan and Lee	<i>E. setosus</i> (Riek) <i>E. hystricosus</i> Riek <i>E. urospinosus</i> (Riek)

Their distributions and those of sympatric *Euastacus* species are listed in Table 1. The only locality north of the D'Aguilar Ranges that supports *Euastacus* but from which *Taudactylus* has not been recorded is Mt Elliot. Given the close similarities in both habitats and distributions of the two genera it might be suggested that Mt Elliot may well support a hitherto undescribed population of *Taudactylus*.

Ingram (1980) and Czechura (1986) discussed the probable mechanism of isolation of *Taudactylus* species in Queensland. The expansion and contraction of rainforest will have affected all species restricted to this habitat and the parallel distributions of *Euastacus* with other fauna requiring similar habitat is therefore to be expected.

Most of the habitats of *Euastacus* in Queensland are assignable to the 'large, relatively wet' rainforest refugia category of Webb and Tracey (1981), where mesic communities occur on summits and gullies on the slopes of wet mountains. Mt Elliot can scarcely be regarded as 'large', but the other criteria apply. Webb and Tracey (1981) might consider Kroombit Tops, together with the nearby Many Peaks Range, as a 'topographic-edaphic-climatic' isolate but the rainforest there is still supported by heavier rainfall (average 1800 mm per year) than in adjacent areas (McDonald and Sharpe, 1986).

Kershaw (1981) and Webb and Tracey (1981) discussed the probable patterns of climate and expansion and contraction of rainforests in Queensland during the Quarternary. Topography and soils permitting, rainforests essentially expand with increasing effective moisture and are therefore most extensive during periods of high

warmth and rainfall. *Euastacus* is confined to rainforest in central and north Queensland but its requirement of cool water conditions restricts the genus to montane areas. Therefore caution should be exercised in extrapolating *Euastacus* distributions from that of rainforests. The increased temperatures conducive to expansion of rainforest may in fact result in contraction of the suitable coldwater habitat of *Euastacus* to greater elevations. Hence, *Euastacus* distributions may have been more extensive prior to the end of the last glaciation (10,000-8,000 years B.P.) when temperatures and rainfall began to rise. Species of the more widespread and warm water tolerant parasitic genus *Cherax* inhabit rainforest streams at lower elevations to *Euastacus* (pers. obs.) and it might be predicted that the distribution of this genus will have expanded and contracted inversely to that of *Euastacus*.

ACKNOWLEDGEMENTS

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A NEW SPECIES OF THE GENUS *FOETOREPUS* (PISCES : CALLIONYMIDAE)
QUEENSLAND

TETSUJI NAKABO AND ROLAND J. MCKAY

Nakabo, T. and McKay, R.J. 1989 11 13: A new species of the genus *Foetorepus* (Pisces : Callionymidae) from Queensland. *Mem. Qd Mus.* 27(2): 563–565. Brisbane. ISSN 0079-8835.

A new species of the dragonet fish family Callionymidae is described from deep water off the Queensland coast. *Foetorepus australis* is characterized by having an extremely high first dorsal fin, a very large eye and darker brown marks on the posteroventral parts of the anal and caudal fins.

□ Pisces, Callionymidae, *Foetorepus*, taxonomy.

Tetsuji Nakabo, Department of Fisheries, Faculty of Agriculture, Kyoto University, Kyoto 606, Japan; Roland J. McKay, Queensland Museum, PO Box 300, South Brisbane, Queensland 4101, Australia; 18 August, 1988.

One specimen of an unusual callionymid fish was collected from the upper part of the continental shelf (380 m deep) of Queensland. This specimen belongs to the genus *Foetorepus*, which was first described by Whitley (1931) and redescribed by Nakabo (1982). *Foetorepus* includes some 16 species that are known mostly from sandy-muddy bottoms in deep water near the edge of the continental shelf, and on banks or seamounts. Because the combination of characters of our unusual specimen is not found in other species of *Foetorepus*, we here describe it as a new species.

Methods of counts and measurements follow Nakabo (1982). Vertebral number is counted from the soft X-ray negatives.

***Foetorepus australis* sp. nov.**
(Figs 1–2)

MATERIAL EXAMINED

HOLOTYPE: QM (Queensland Museum) I.21255, a male, 66.8 mm SL, off Queensland, 23°59'S, 152°59'E, 380 m, Queensland Fisheries Service, August 8, 1983. In spirit.

DIAGNOSIS

Body elongate and almost cylindrical. Eye very large. Preorbital canal absent. First dorsal fin extremely high, 1st spine longest. Distal margin of 1st and 2nd membrane of 1st dorsal fin dark brown, 3rd membrane almost brown. Distal margin of 2nd dorsal fin dark brown. Posteroventral parts of anal and caudal fins darker brown.

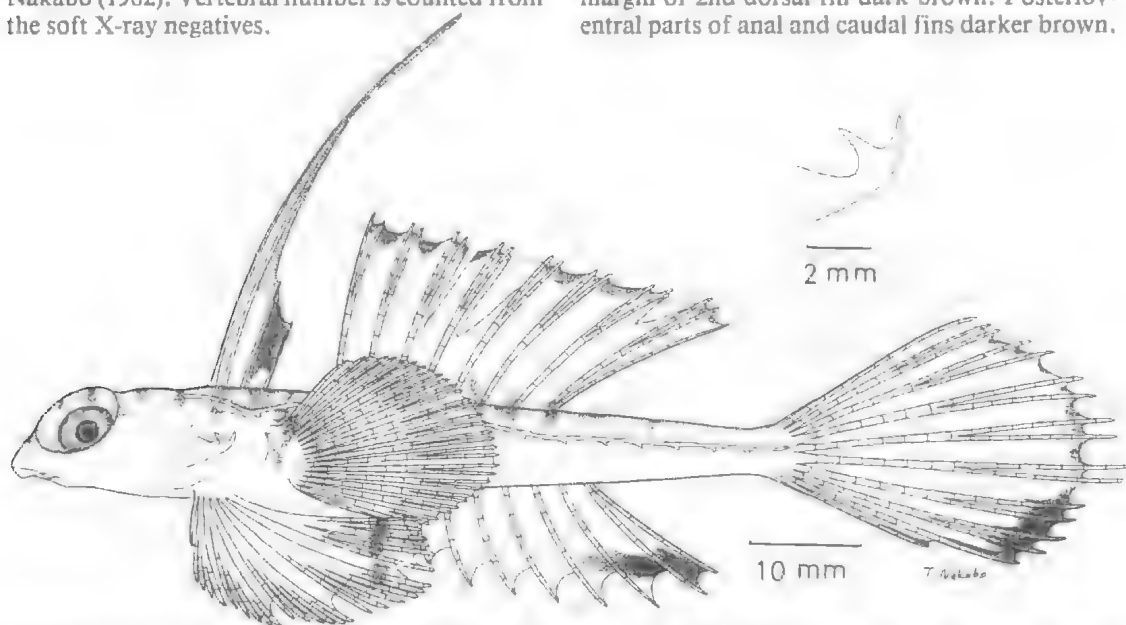


FIG. 1. *Foetorepus australis* sp. nov.; holotype QM I.21255, a male, 66.8 mm SL. Upper, left preopercular spine. Lower, lateral view.

DESCRIPTION

Dorsal fins IV-8; Anal fin 7; Pectoral fin i + 19; Pelvic fin I, 5; Caudal fin i + 7 + ii; Vertebrae 7 + 14.

Proportional measurements as percent of standard length; body width, 19.3; body depth, 15.0; caudal peduncle depth, 6.1; predorsal length, 27.7; caudal fin length, 47.5; head length, 28.6; eye diameter, 12.3; snout length, 7.2; upper jaw length, 8.5; interorbital width, 2.4; 1st dorsal spine length, 59.6; 2nd dorsal spine length, 38.2; 3rd dorsal spine length, 14.7; 4th dorsal spine length, 9.3; 1st dorsal ray length, 24.0; last dorsal ray length, 26.2; 1st anal ray length, 9.9; last anal ray length, 21.7; pectoral fin length, 28.3; pelvic fin length, 34.7; anal papilla length, 1.6

Body elongate, almost cylindrical, slightly depressed. Head slightly depressed. Eye very large. Snout very short, covering almost all of upper jaw. Interorbital space very narrow, and slightly concave. Gill-opening small, oval, placed a little behind origin of 1st dorsal fin. Preopercular spine without an antrorse process at base and with an upward process on inner side; its posterior tip strongly upcurved. Upper jaw protractile; its posterior and exceeding anterior edge of eye. Nostril with a very short tube on each side of preorbital region. Teeth on jaws villiform in broad bands. Palatine and vomer toothless. Anal papilla conical. Infraorbital canal without branch, reaching posteroventral edge of eye; postocular commissure connected to preoperculomandibular canal; preorbital canal absent (Fig. 2). Lateral line single, with very short branches downward on posterior half, reaching base of caudal fin; lateral line of opposite side interconnected by a transverse branch across occiput, but not on dorsal surface of caudal peduncle.

First dorsal fin extremely high, beginning a little before gill-opening; 1st spine longest. Dorsal rays

branched distally except posterior branch of last ray; upper margin almost straight. Anal rays unbranched distally; last ray divided at base; length of rays increasing posteriorly. Pectoral fin rounded, extending beyond 6th dorsal ray. Pelvic fin rounded, reaching 1st anal ray, and connected by membrane to middle part of pectoral fin base. Caudal fin rounded and elongate; middle rays somewhat filamentous.

Color in 50% isopropyl alcohol. Body white with some dark marks on dorsal surface and opercular region. First dorsal fin with dark brown distal margin on 1st and 2nd membranes, and almost dark brown on 3rd membrane. Second dorsal fin transparent with dark distal margin, and with some dark marks near base. Pectoral fin transparent. Pelvic fin transparent with 2 dark brown marks on posterior part. Anal fin transparent with a darker brown line on posterior distal margin. Caudal fin transparent; upper half with narrow dark brown distal margin, lower half with broad darker brown distal margin.

REMARKS

F. australis is similar to *Foetorepus bicornis* (Norman, 1939) from Zanzibar, western Indian Ocean, in having a very high 1st dorsal fin, a very large eye and in the coloration of the anal fin, but differs in the relative length of 2nd to 1st dorsal spines (the former shorter, the latter almost the same), and in the coloration of 1st-2nd dorsal and caudal fins (in *F. bicornis* the 1st dorsal fin is dark with 4 oblique white lines, 2nd dorsal fin with a broader dark band on the distal margin and the caudal fin with a broad dark band on the distal margin).

F. australis differs from the other two Australian *Foetorepus* species, *F. phasis* (Günther, 1880) and *F. apricus* (McCulloch, 1926), in the preopercular spine (the former bicuspid, the latter two

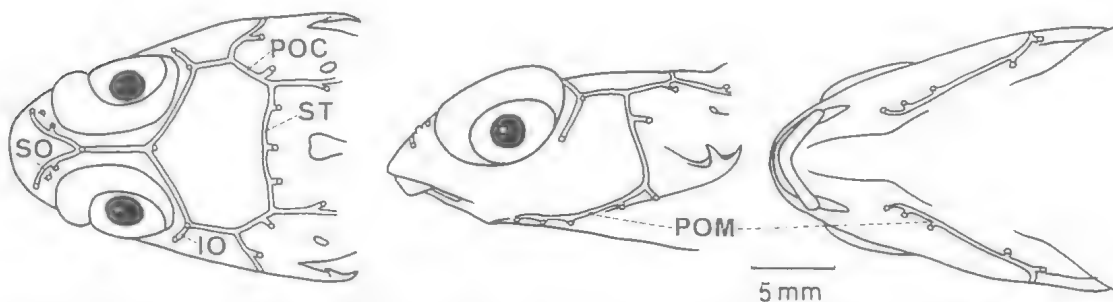


FIG. 2. Cephalic lateral line of *Foetorepus australis*, holotype. Left, dorsal view. Middle, lateral view. Right, ventral view. IO, infraorbital canal; POC, postocular commissure; POM, preoperculomandibular canal; SO, supraorbital canal; ST, supratermporal canal.

tricuspid); the membrane connecting the pelvic fin to the base of the pectoral fin base (present in the former, almost absent in the latter two); and in coloration. *F. apricus* is synonymized with *F. phasis* by Johnson (1971) and Fricke (1981, 1983), but is a separate species to be discussed in a forthcoming paper by the senior author.

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THE FIRST FIFTY YEARS OF X-RAY USE IN QUEENSLAND

R.A. PATERSON

Paterson, R.A. 1989 11 13: The first fifty years of X-ray use in Queensland. *Mem. Qd Mus.* 27(2): 567–588. Brisbane. ISSN 0079–8835.

The discovery of X-rays by Röntgen in 1895 was a dramatic event in the history of science in general and medicine in particular. The use of the new technology was demonstrated in Queensland within months of its discovery. The early practitioners were dedicated people and some suffered radiation injuries. Thanks to their efforts, X-ray facilities in Queensland in the subsequent half-century were developed to serve a widely scattered population. An outstanding attribute of the early radiologists was their involvement in other spheres of scientific and community endeavour.

□X-ray, radiation injury, history, Queensland.

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On Friday 8 November 1895, Wilhelm Conrad Röntgen, director of the Physical Institute of the Maximilian University in Würzburg, Germany, made a dramatic discovery. He discovered that when a high tension current was passed through a high vacuum or Crookes tube, rays emanating from it penetrated objects opaque to ordinary light and affected a photographic plate.¹ In a paper delivered to the secretary of the Würzburg Medical Society on 28 December 1895, he gave the name X-rays to those previously unknown rays.² The paper was published immediately and on 1 January 1896 Röntgen sent reprints together with examples of his first X-ray pictures to a number of colleagues.³ Within weeks the discovery was acclaimed as an event of major historical importance for both experimental science and medicine.⁴

The date of origin of the medical specialty that emerged from Röntgen's discovery is thus precisely known. Although the specialty is now termed radiology in Australia and many other countries, the term roentgenology is used in others in recognition of its founder. The late Dr Colin Macdonald of Melbourne has left an excellent account of Röntgen's personality and career.⁵

News of the discovery was reported in the Australian press on 31 January 1896.⁶ The story of the Australian X-ray innovators, both in physics and medicine, was told by J.P. Trainor in *Salute to the X-Ray Pioneers of Australia* published in 1946. Trainor noted at the conclusion of the chapter concerning Queensland:

'The all-too-brief records of early X-rays in Queensland reveal little of the work that must have gone in that vast state . . . One can only conclude that medical men were more concerned with immediate results than with compiling records for the use of future historians.'⁷

It is in the context of those remarks that I have undertaken this study. In a broader setting, the period 1895–1945 was dominated by two World Wars and the Great Depression. Radiology in Queensland did not escape their effects. I have not detailed all the technical developments that occurred but rather have attempted to place the progress of X-ray services in Queensland in the broader socio-medical sphere.

The passage of time has left alive only three practitioners who commenced their radiological training during the subject period — Drs Jim Bell, Gordon Donnan and Eileen Harrison (*née* Reimers). Obituary notices and anecdotes tend to present those of earlier times in a rosy light but one feature concerning many of the early Queensland radiologists must be emphasised. In various ways they made important contributions to the wider community. Outstanding among them were Hugo Flecker, Val McDowall and Clive Uhr who was knighted in 1972 in recognition of his services to Queensland. As well, their humanity was evidenced by deep concern for the welfare of their patients.

It is to all those involved with the development of X-ray services in Queensland — dentists, medical practitioners, nurses, physicists, radiographers, technicians and trade suppliers alike, that this study is dedicated. Omission of names and events can be attributed to my ignorance and not to any deliberate intention on my part.

THE EARLY YEARS

The first X-ray demonstration to the medical profession in Queensland was made by Mr J.W. Sutton in his laboratory at 29 Eagle Street,

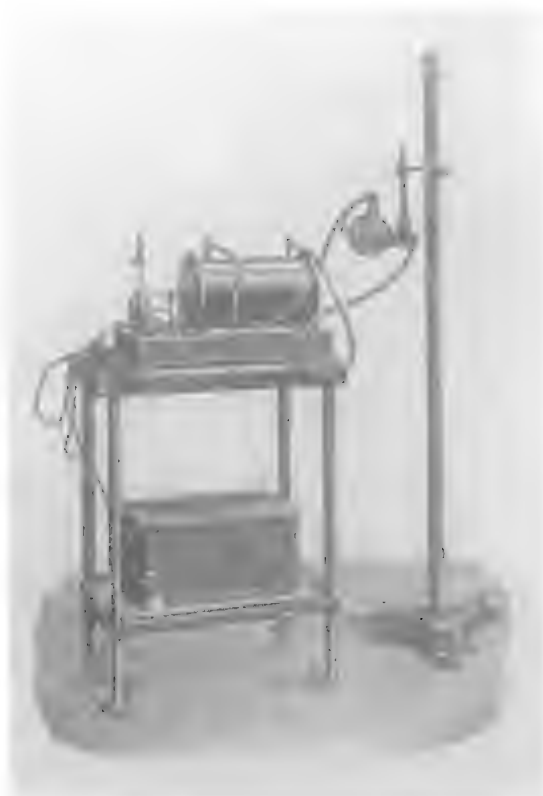


FIG. 1. Early X-ray machine used in Queensland. Prior to 1901 more than fifty of this type had been sold in the state, an indication of the ready acceptance of the discovery.

Brisbane on 16 July 1896.⁸ Mr Sutton had an engineering workshop at Kangaroo Point on the opposite side of the Brisbane River to his city office and laboratory.⁹ His medical audience included Drs Love, Lyons, Rendle, Taylor and Wheeler as well as Mr J. Campbell, president of the Brisbane Photographers' Society. A further demonstration was made at a meeting of the Royal Society of Queensland on 8 August 1896.¹⁰

Drs David Hardie and Wilton Love, who had honorary positions at the Hospital for Sick Children in Brisbane, were the first to use X-rays for clinical purposes in Queensland.¹¹ In 1913 Dr Hardie was knighted for his services to medicine. At a meeting of the Queensland Medical Society on 10 November 1896 Dr Hardie fluoroscopically demonstrated the chest and forearm bones of a child and in 1897 after another meeting concerning childhood fractures it was reported 'that his

[Dr Hardie's] practice, in private, as well as with cases from the Children's Hospital, was to take a skiagraph before setting, another after and if the latter was unsatisfactory to reset.'¹² Dr John Thomson, surgeon at the adjacent General Hospital, reported that Dr Love had localised a shotgun pellet in a patient's ankle thus facilitating the pellet's removal.¹³ Dr Love is regarded as the pioneer X-ray specialist in Queensland and his first equipment comprised a 6 inch spark coil with a mercurial interrupter.¹⁴ Primary current was derived from a bichromate battery and the tube was less than 3 inches in diameter. Dr Hardie's equipment comprised a Newton 6 inch coil, 'Focus' tube and Leclanche battery.¹⁵ An exposure of 20 seconds was required for digital examinations. The pioneering efforts of Drs Hardie and Love were officially recognised at the Hospital for Sick Children when X-ray apparatus was installed in 1908.¹⁶

Another Brisbane X-ray pioneer was Dr Andrew Doyle who first used X-rays in northern New South Wales in 1900.¹⁷ After a period of practice in Roma and St George he came to Brisbane and in 1908 was appointed honorary radiographer at the General Hospital where X-ray apparatus valued at £150 had been installed in 1903.¹⁸ In 1909 Dr Doyle published his findings in relation to the therapeutic effects of X-rays on bacterial skin



FIG. 2. Dr Wilton Love considered to be Queensland's first X-ray medical specialist.



FIG. 3. Dr David Hardie (circa 1910). In 1913 he was knighted for his services to medicine.

disease.¹⁹ In 1914 he supervised the installation of X-ray equipment at the Mater Hospital and subsequently served there in an honorary capacity.²⁰

Queensland is decentralised and the early provision of X-ray facilities in extra-metropolitan centres reflects that fact. Dr Vivian Voss of Rockhampton was in London at the time of Röntgen's discovery. He purchased X-ray equipment and was using it soon after his return to Queensland.²¹ By 1906 Dr Robert Huxtable of Charters Towers had already replaced his first X-ray apparatus. He was the first in Australia to install a Koch transformer with Noden rectifying valves which allowed the use of alternating current.²² Dr Walter Nisbet of Townsville had experience with X-rays while serving in South Africa during the Boer War. His equipment was of high quality, comprising a 10 inch spark coil, gas engine and generator. He ultimately suffered from the effects of irradiation dermatitis and died en route to Brisbane to have two fingers amputated.²³

Then as now, medical users of X-ray relied on electrical engineers, technicians and trade suppliers. In addition to Mr J.W. Sutton, Messrs Barton and White, who were electricians, were early providers of X-ray services in Brisbane.²⁴ Mr F. Engels who worked for A.C. Jackson, a Brisbane firm of electrical engineers, is said to have explained the intricacies of electrical high frequency to Mr G.R. King, a Brisbane ambulance



FIG. 4. Dr Walter Nisbet's X-ray room in Townsville. His experience with X-rays began while serving in South Africa during the Boer War.

officer.²⁵ In 1900 Mr King took an X-ray apparatus to Townsville when he was appointed senior officer to the newly established ambulance branch in that city. He was able to advise Dr W. Bacot, superintendent at the Townsville Hospital of deficiencies in the supplied X-ray apparatus and X-rayed the patients of other doctors. He was later employed by Dr Nisbet and subsequently returned to southern Queensland where he was still working in the X-ray department at the Ipswich Hospital in 1945. His remarkable career thus spanned the first 50 years following Röntgen's discovery.

Carl Zoeller had supplied Mr King with an X-ray tube at a cost of 30 shillings before he left Brisbane for Townsville in 1900.²⁶ In 1896 Zoeller had commenced business at the 'Courier Building', Queen Street as an importer and manufacturer of surgical and veterinary instruments.²⁷ In a trade brochure circulated in 1901 he advised that he had already sold 50 X-ray machines in

Queensland.²⁸ In a 1905 brochure he notified the medical profession that a room, fully equipped with the latest Schall X-ray and high frequency apparatus, was available for the exclusive use of the medical profession at his Queen Street premises and that Miss Payne, a trained assistant, would carry out treatment according to referring physicians' instructions.²⁹

The range of X-ray uses, both diagnostic and therapeutic, increased rapidly in Queensland in the early years following Röntgen's discovery. At a meeting of the Queensland branch of the BMA in 1912 Dr D.A. Cameron presented radiographs of renal calculi.³⁰ The superintendent of the Roma Hospital reported in 1914 that, 'the institution of an X-ray unit, electrical department, and of a bacteriological laboratory was essential, in order that the work of the hospital might be carried out in a satisfactory manner'.³¹

A major technical advance in X-ray tube con-



FIG. 5. The X-ray room at the premises of Carl Zoeller at Queen Street, Brisbane, 1905. The technician was Miss Payne and the seated 'patient' was Miss Bunzli, one of Zoeller's employees.

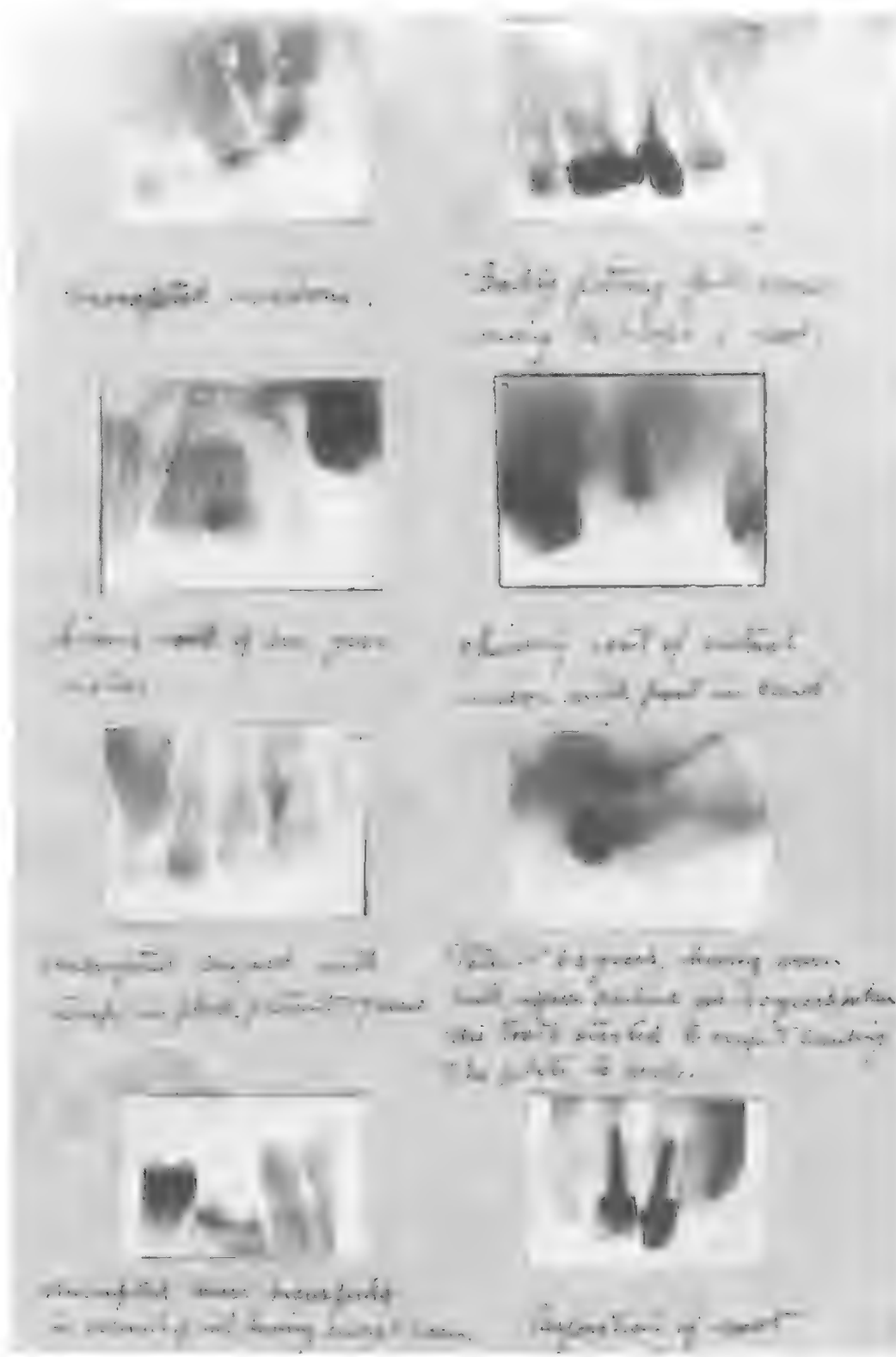


FIG. 6. Dental films dated 20 October 1909, possibly the first taken in Queensland.

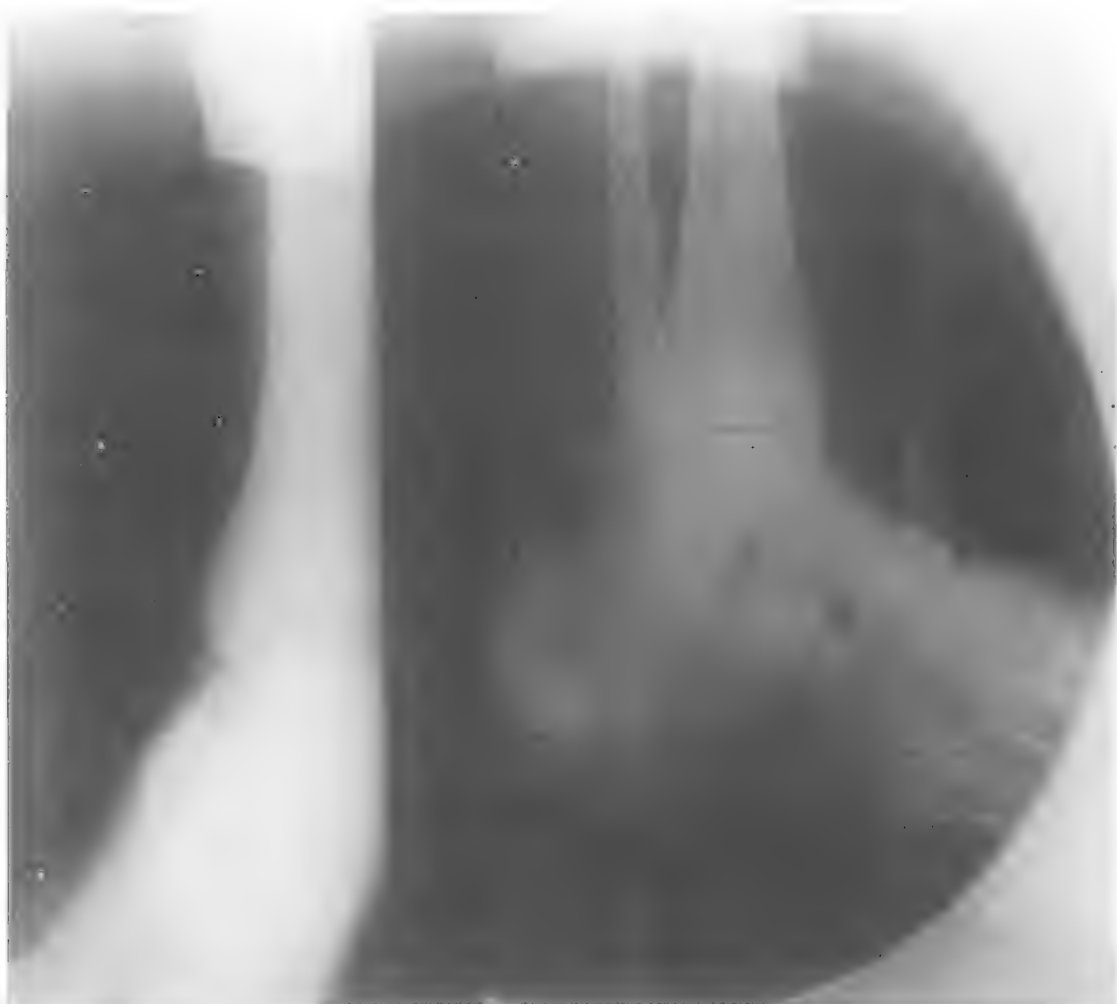


FIG. 7. A glass X-ray plate showing the ankle region. The supply of suitable glass was dramatically interrupted by the German occupation of Belgium. The result was a search for a new type of film base and the first of the modern types of film was produced by Kodak in 1918.

struction occurred in 1913 when Coolidge incorporated the hot filament into the cathode. The older, low vacuum tube had limited possibilities for radiation control, whereas the improved hot cathode, high vacuum tube had a stable and reproducible output and independent control of radiation quality and quantity.³² The outbreak of the First World War stimulated the development of X-ray film as a replacement for the then universally popular glass plates. Belgium was the major supplier of suitable glass but export ceased following the German occupation. In 1918 Kodak began to market *Dupli-Tized* X-ray film.³³ Emulsion was coated on both sides of the base in contrast to the single and often uneven application on the glass plates.

BETWEEN THE WARS

The Mater Hospital X-ray department was modernised in 1920. New plant was installed and duplitized film replaced the old glass plates. A new era began which 'brought joy to the heart of Dr Nisbet, in charge of the department, and Sister M. Augusta, his capable assistant'.³⁴ An increase in the departmental workload led to the appointment in 1924 of Dr B.L.W. Clarke, who had recently obtained the DMRE (Cantab.), as honorary assistant roentgenologist. Dr Clarke was also appointed honorary radiologist at the Ipswich Hospital in the same year.

In 1920 an appointment of long-term significance was made at the Hospital for Sick Children.



FIG. 8. Dr Tom Nisbet, son of Dr Walter Nisbet of Townsville, practised in Brisbane and Ipswich before he went to Sydney in 1929. A leading Australian radiotherapist he was the foundation president of the Australian and New Zealand Association of Radiology.

Sister B. Maynard was appointed assistant radiographer following Dr McDowall's resignation.³⁵ The indefatigable lady remained in charge of the X-ray department until 1946 when she was succeeded by Mr Les Payne.³⁶ She considered that her services during the Second World War, past the normal retiring age, to be a contribution to the war effort.³⁷

Drs Clarke, McDowall and Nisbet were to be prominent in state and national radiological affairs for many years. The 1920s saw the emergence in Queensland, with the earlier exception of Dr A.A. Doyle, of practitioners who specialised solely in radiology. In those years differentiation between diagnostic and therapeutic radiology did not exist. However, trends in that direction were developing and are illustrated by reference to the early career of Dr A.T. (Tom) Nisbet. He began X-ray practice in Townsville with his father and later moved to Brisbane when he was appointed to the Mater Hospital in 1921 and the Hospital for Sick Children in 1923. He practised in partnership with Dr Burnett Clarke at 'Lauriston', Wickham

Terrace between 1924 and 1928 and also established a practice at East Street, Ipswich in 1927.³⁸ He went to Sydney in 1929 and, in 1935, became the foundation president of the Australian and New Zealand Association of Radiology. He remained in that position until 1947 when he was succeeded by Dr Val McDowall. With hindsight, his distinguished career in radiotherapy could have been predicted by the quality of a paper which he presented at a meeting of the Queensland branch of the BMA on 7 November 1924. He described his early experience with the use of deep X-ray therapy for both malignant and non-malignant conditions.³⁹ This paper reveals Dr Nisbet's careful documentation of the pathological and therapeutic aspects of each case and his utmost regard for the well-being of his patients. He referred to the financial aspects of deep therapy treatment:

'Everyone, patient and medical man alike, is



FIG. 9. Dr Burnett Clarke, the first Queensland radiologist to obtain a higher degree in the specialty and a tireless worker for the Queensland Cancer Trust. He became a prisoner of war following the fall of Singapore in 1942.



FIG. 10. Dr Val McDowall, remembered as a pioneer of broadcasting by both radio and television in Queensland.

interested in the question of cost of this treatment. It is expensive but it must be realised that before a plant is installed and in running order £2,500 has been laid out which at 7% interest quite apart from depreciation, works out at £3 10s. per week. Add to this all the extra staff necessary, repairs, replacements and so forth and Coolidge tubes costing £86 apiece (none of which I have been able to use for more than two hundred and fifty hours and some considerably less) and you will understand that treatment given for two hours each dose cannot be given at half a guinea a time'.⁴⁰

Dr Val McDowall had succeeded Dr A.A. Doyle as honorary radiologist at the Brisbane General Hospital. He was the dominant figure in Queensland radiology between the wars and for a considerable period thereafter. Initially his practice was

located at 'Preston House', 371 Queen Street. In conjunction with his great friend Mr Tom Elliott of the Stanford X-ray and Radium Co., he pioneered broadcasting by radio and television in Queensland in 1920 and 1935 respectively.⁴¹ The radio-station 4CM was located in a studio next to 'Preston House' and broadcasts were made bi-weekly. The first television transmission was made from the Old Observatory, originally the convict mill, on Wickham Terrace.⁴² In 1936 he relocated his practice to 'Ladhope', Wickham Terrace.

When Dr McDowall commenced specialist practice in Brisbane in 1919 he practised both as a dermatologist and radiologist.⁴³ In 1926 Dr J.W. Heaslop was appointed assistant radiographer at the Brisbane General Hospital. (The term radiographer was then used on occasions for both medical and technical appointments in X-ray departments). Dr Heaslop, who had post-graduate experience in London, Edinburgh and New York, had been appointed honorary dermatologist at the Children's and General Hospitals in 1923.⁴⁴ In that era the extensive treatment of skin disorders by

H.W. CLARK MEMBERS D.M.F.P.
TEL. CENTRAL 6964.

"LAURISTON"
WICKHAM TERRACE,
BRISBANE.

Dear Mr Cook/
Thank you for sending Beryl
along. It seems an awful shame
that the psoriasis should recur so
badly. I will go & see Dr Heaslop
before next Wednesday & talk to him
about treatment. I think her skin
is excellent
Yours truly
Tom Nisbet

FIG. 11. Letter dated 25 August 1928 from Dr Tom Nisbet concerning Miss Beryl Cook who received radiotherapy for psoriasis in 1923 when aged seven. She suffered severe radiation dermatitis and required bilateral lower limb amputations in the 1970s when epitheliomata developed.

radiotherapy established a close relationship between the practice of dermatology and radiology, although not without tension in some centres.⁴⁵

In 1929 the first formal X-ray training position in Queensland was created at the Brisbane General Hospital when Dr C.W. Uhr was appointed radium and X-ray registrar.⁴⁶ He completed training in 1932 and commenced private practice at 'Ballow Chambers', Wickham Terrace. In 1938 he was appointed senior visiting radiologist at the Brisbane General Hospital.⁴⁷

Steps to rationalise non-surgical methods of cancer treatment on a statewide basis in Queensland began at the Mater Hospital in 1928. The establishment of a treatment centre followed Queensland's allocation of radium, purchased by the Commonwealth Government in 1927,⁴⁸ and has been described by H.J. Summers;

'The Queensland Cancer Trust, a body established by funds raised through public subscriptions and the Queensland Branch of the British Empire Cancer Campaign, purchased a modern



FIG. 12. Dr Clive Uhr immediately before his embarkation in Sydney for overseas service with the 8th Division of the A.I.F. He became a prisoner of war following the fall of Singapore in 1942. In 1972, he was knighted for service to Queensland.



FIG. 13. Dr Hugo Flecker, one of the pioneer Melbourne radiotherapists who left that city for Cairns during the Great Depression. He was renowned for his studies in natural history. The Herbarium in Cairns is named in his honour.

deep therapy outfit and installed it in premises provided in the Mater Hospital grounds rent free. So began a service which was to prove of inestimable value to people suffering from malignant diseases. It was the first deep therapy treatment clinic in Brisbane. Beds were made available in the wards for the treatment of patients by radium and deep X-ray'.⁴⁹

The preceding description of events in Brisbane does not mean that developments in X-ray facilities were confined to Queensland's capital but rather it reflects the paucity of recorded information from other areas. In the 1920s Dr H.J. Taylor installed diagnostic and therapeutic X-ray equipment in Townsville and his services were highly regarded throughout north Queensland.⁵⁰

In 1932 Dr Hugo Flecker, a pioneer Melbourne radiotherapist, left that city to establish a practice at Cairns.⁵¹ His interests transcended medicine and included research into many aspects of biology. The box jellyfish (*Chironex fleckeri*) was named in his honour in addition to other botanical and zoological species.⁵² His son Dr Pat Flecker of Townsville has written:

'In the early 20s he went by train (from

Melbourne) to Copley, in South Australia, and then rode a camel the next 70 miles to Radium Hill, near Mt. Painter, where a company called Radium and Rare Earths had a mine. They dug their ore, choosing this by means of a gold leaf electroscope, because the Geiger counter hadn't been thought of, and sent this by pack camel, train and ship to somewhere in Europe for processing. The mine was made uneconomic by the discovery of pitchblende in Canada, which broke the monopoly of the Belgian Congo. . . . In his own practice he had his deep therapy plant, which was powered by current which was rectified by a mechanical rectifier. This gadget took up more space than the X-ray plant, and was most impressive to watch — better than any fire-works display. . . . During the Great Depression, my father moved to Cairns. He was the first consultant in any speciality in the North. He took with him his mechanical rectifier and the machine to go with it, but used this very little. He did some work for the Queensland Radium Institute, but when he learned of the superior equipment available in Brisbane, he phased out this work, and carried out diagnostic work only'.⁵³

The discovery of X-rays was soon followed by the recognition of some of their dangers. Two of Australia's medical X-ray pioneers, Drs L. Herschel Harris and F.J. Clendinnen, published papers on the dermatological uses and dangers of X-rays in 1901 and 1908 respectively.^{54,55} Unfortunately, both were to succumb to the effects of irradiation, Dr Clendinnen in 1913 and Dr Herschel Harris in 1920.⁵⁶ Irradiation injuries continued to afflict both operators and patients in subsequent decades. In Queensland, Drs B.L.W. Clarke and R.G. Quinn developed severe dermatitis of the hands following prolonged, unprotected exposure during fluoroscopy. Dr Quinn's surgical career was ruined by the severity of his burns. It had been his practice at the Children's Hospital to manipulate fractures using fluoroscopic control. More tragic was the death in 1931 of Mr Lawrence Scarrabelotti at the age of 41 from malignancy considered to be induced from excessive irradiation.⁵⁷ Among other X-ray duties he assisted Dr Quinn during fluoroscopic procedures.

In the 1930s two Brisbane dentists, Messrs W.E. Earnshaw and A.U. McNaught suffered irradiation burns as a result of holding film during exposure. Mr Earnshaw required amputation of his right ring finger because of intractable pain associated with chronic ulceration.⁵⁸ He died in

1947 at the early age of 50 from Hodgkin's disease. Mr Arthur McNaught is remembered by Dr F.R. Vincent who acted as his locum in 1934:

'In retrospect it seems remarkable that there was a specialty in dental radiography at that time but demand was quite heavy from dentists for full mouth examinations (12–15 films), apical lesions, root fillings, impacted wisdom teeth and particularly as a precursor to orthodontic treatment. The equipment was huge, covering one wall of the room, across the ceiling and down the other side and was black in colour. The whole apparatus created quite a degree of tension in the patients because of the fairly high degree of noise and the Heath Robinson appearance. I believe this was one of the main factors leading to the holding of the films in the patient's mouth in order to immobilise them, thus causing the burning of the fingers of Eric Earnshaw and A. Ure McNaught. Having seen what happened to them I was determined never to hold a film during exposure. At that time, there was little thought of shielding the patient or the operator'.⁵⁹

The first formal step to initiate professional organisation among radiologists in Queensland occurred on 21 February 1930 when Drs B.L.W. Clarke, J.W. Heaslop, V. McDowall, A.J. Reye and L.J. Spence met to form a Radiological Section of the Queensland Branch of the BMA.⁶⁰ Drs Clarke and Heaslop were appointed chairman and secretary respectively. The interests of that body were not entirely scientific as problems with the Workers Compensation Office were discussed and a list of standard fees was adopted as follows:

'Fractures:	from £2:2:0	to £3:3:0
Head:	" £3:3:0	to £4:4:0
Barium enema:	" £3:3:0	to £5:5:0
Barium meal:	" £5:5:0	to £6:6:0
Gall bladder:	" £4:4:0	to £5:5:0
Chest:		£3:3:0
Dental films (single):		£1:1:0
Dental films (full set):		£3:3:0
Localisation of foreign body:		£3:3:0
Urinary tracts:		£3:3:0
Pyelogram:		£3:3:0
Spine — Lumbar:		£3:3:0
Spine — Dorsal:		£3:3:0
Spine — Cervical:		£2:2:0
X-ray treatment (minimum fee):		£2:2:0

Fee for Clergy and Nurses: Minimum half the usual fee. Doctors and dependants free'.⁶¹

On 20 January 1933 Dr Nisbet wrote from Sydney to Dr McDowall outlining proposals to form an Australian Institute of Radiology.⁶² On 16 May 1934 members of the Radiological Section met and agreed to join the proposed national body.⁶³ Those present were Drs Clarke, Heaslop, McDowall, Reye and Uhr and they also approved the membership application of Dr G.W. Mason. In 1921 Dr Mason had commenced practice in Townsville in succession to Dr Nisbet. The proposed Australian body became Australasian and the inaugural meeting of the Australian and New Zealand Association of Radiology (ANZAR) was held in Canberra on 17 May 1935.

The appointment of the X-Ray and Other Electro-Medical Equipment Advisory Board on 1 May 1935 was an event of considerable importance in relation to the provision of X-ray facilities in Queensland. In the preamble to its first annual report the board noted:

'For some considerable time the situation with regard to X-ray and other electro-medical equipment in Queensland has been recognised as being in an unsatisfactory state. Standards have been, to a large extent, arbitrary, and applications have been determined more by the salesmanship of visiting representatives of firms than by the actual necessities of the districts'.⁶⁴

The board's chairman was Sir Raphael Cilento, director-general of Health and Medical Services and the secretary was George Watson of the Chief Secretary's Department. The other members were Arthur Boyd, lecturer in mechanical and electrical engineering at the University of Queensland and Val McDowall, senior radiologist and radium therapist at the Brisbane General Hospital.⁶⁵ The functions and duties of the board are contained in Appendix 1. The board rapidly asserted its authority and was to exert a dominant, centralising role in Queensland radiological affairs in the following decade. It noted in its second annual report:

'It was found that there was a general failure to appreciate that X-ray work is a specialty, and that the provision of a first class apparatus does not necessarily give good service unless the operator has special knowledge and can interpret the resulting skiagrams. This was particularly felt to be the case with regard to the interpretation of barium meal pictures, taken very frequently by operators unskilled in the interpretation of what is, perhaps, one of the most difficult of diagnostic procedures'.⁶⁵

In 1938 the board was in a position to report by reference to a map of Queensland that:

'It will be observed that there are now few material aggregations of population which are not within reasonable reach of some public X-ray plant, and in those few areas where this does not appear to be the case, private plants occasionally supply the necessities of the situation. This, of course, is reinforced further by the increased availability of aeroplane transport, which has made it possible for many persons in remote localities to be brought speedily and with a minimum of disturbance to places in which the most up-to-date radiological service is available'.⁶⁷

In the following year the board published a further map indicating the locations of both public and private X-ray installations in Queensland.⁶⁸ The *Medical Act of 1939* provided for specialist registration and when its provisions became fully effective in 1942 only three out of a total of thirteen specialist radiologists in Queensland practised outside Brisbane.⁶⁹ They were Drs Morris Beale (Toowoomba), Hugo Flecker (Cairns) and Leslie Halberstater (Townsville).

Dr J.G.M. Beale trained as a radiologist in London and obtained the FFR in 1939. He and Dr Flecker were the most scholarly of the Queensland



FIG. 14. Map of Queensland demonstrating the distribution of X-ray plants in public hospitals in 1938.

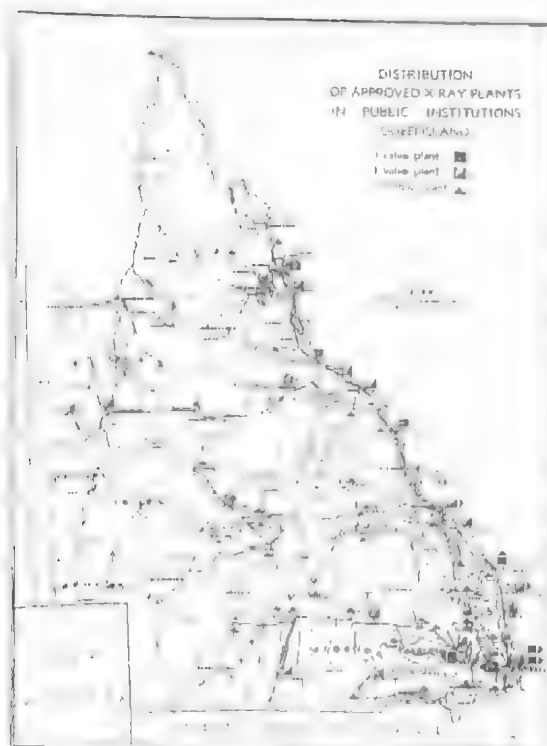


FIG. 15. Map of Queensland demonstrating the distribution of X-ray plants in public hospitals and private practices in 1939. Both this map and the one shown for 1938 indicate the efficient and centralising role of the X-Ray and other Electro-Medical Board founded under the chairmanship of Sir Raphael Cilento in 1935.

radiologists in both radiological matters and other pursuits. With regard to the latter Dr Beale was a classicist while Dr Flecker's studies in biology have already been mentioned. Dr Jim Bell remembers Dr Beale:

'Always a gentleman, learned in the arts, meticulous in radiology, he would in his lunch hour stroll back and forth on his lawn reading a Greek classic in the original until the stroke of two when he would doff his jacket, don a gown, and call the first patient from the waiting room'.⁷⁰

His reports, written in long hand, contained references to the English and Continental radiological texts as well as to the journals from both sides of the Atlantic. In short, he was a true consultant.

Meanwhile to the south of Toowoomba in the border town of Stanthorpe, another radiological career was developing. Dr Harry Masel, who had conducted a general practice there since 1928, installed a modern fluoroscopy unit. His radiol-

ogical opinion was highly regarded in the region. After the Second World War he moved to Brisbane to commence specialist practice.

A description of country radiological practice in Queensland in the 1930s and early 1940s would be incomplete if it did not refer to the experiences of Dr Jim Bell whose career as medical superintendent of the hospitals at Alpha, Aramac, Bowen and Toowoomba spanned the period between 1933 and 1953. He wrote:

'There were Government specifications for X-ray machines at that time and two of these were noteworthy, namely that the installation was to be fitted with a hand piece timer and be capable of producing a radiograph of a lateral lumbar spine which had literally to be produced. I saw some of them and am quite sure that more than one slim junior office girl had had a brief career in modelling. At 10-15 ma I don't know about the skin dose but never mind.

The machine at Bowen was a Victor Wantz with a Coolidge tube, the filament of which was concentrically disposed. I don't know what the focal spot was but Watson Victor sold me an XP1-4 as a replacement. Service came from Brisbane once a year. The dark room was an enclosure between the tall stumps under the maternity ward which was built on a rather steep hillside. The machine itself was housed in the maternity day-room. There was no fluoroscopy but in the three years I was there I did the occasional I.V.P.

Jack Morley was the service engineer who came up from Brisbane. His boss was Harold Bull and when you visited Harold he would switch on his forty watt fluorescent light to show how much light it gave for a little current, such being the technology of the late thirties. Jack made the mistake once of servicing Bowen in the summer and was heard to remark that we developed our film at a temperature at which most people ate their soup. No matter — we had xrays.

Three years in Bowen and the next one came up. It was Toowoomba and a knowledge of xrays was required . . . The next incumbent but one before me in the position had been Spencer Roberts.⁷¹ I know little of him except that he was one of the founding figures of radiology in Queensland and had left behind a glass case of tubes of all shapes and sizes, all with cold cathodes, one with the asbestos side tube for softening it and one, I fancy for therapy with an anode shaped like a corkscrew. I didn't have the sense to preserve them and I don't know what happened to them.

Suffice to say that the installation was a Victor Snook with mechanical rectification which soon had to be converted to self-rectified operation because of radio interference during the war. There was a Kearsley stabilizer, open overheads and cord reels. The fluoroscopy unit was Victor table, all plated rods and polished wood, with two positions, up and down, and nothing in between, so I christened it the good old Duke of York. The timer was mechanical with a large clock face and would measure a tenth of a second with tolerable accuracy and 75 ma was the maximum tube current.

We used to screen on 5 ma; it wasn't until later that protection was really put on the map, and anyway we were flat out protecting ourselves from high tension rods and wires in the dark. I myself have touched a dangling wire from a cord reel with an enema can held too high. Maybe the tube was not switched on, I don't remember — I was a bit dashed when I was told that it would have been only ten thousand volts, and in any case the patient didn't complain. Maybe the current followed my sweaty body to earth, maybe he was or wasn't hetero — I didn't ask and never found out.

Another time, I thoughtlessly flexed my knee under the table while screening a foreign body. Fortunately the side of my calf was pressed hard against the table frame which was earthed and I got a tiny exit burn . . . All this time I never saw a radiographer. Radiography was the province of the sister rostered on outpatients'.⁷²

In 1932 Dr E.W. Casey, known to his wide circle of friends as 'Case', succeeded Dr Clive Uhr as registrar at the Brisbane General Hospital and in 1938 became the hospital's first radiology supervisor. Those who knew him in Brisbane carry the fondest memories of him. Dr Aubrey Pye, former superintendent of the Brisbane General Hospital, and who almost certainly has met more doctors in Queensland than any other person, still recalls the exact place on a hospital stairway where he first met 'Case'.

Dr Casey, together with Dr H.C. Webster of the University of Queensland, Mr John Nebe of the Mater Hospital Cancer Clinic and Dr C.E. Eddy, director of the Commonwealth Radium Laboratory, advised the Queensland Government early in 1939 with regard to the purchase and installation of a deep therapy unit at the Brisbane General Hospital.⁷³ The association of Drs Casey and Eddy did not end there. Both were deeply committed to the initiation of formal training for radiographers and are remembered as the 'fathers' of the Aus-



FIG. 16. Dr Edward Casey, known universally as 'Case'. Founded the inaugural training course for radiographers in Queensland and together with Dr Cecil Eddy of the Commonwealth Radium Laboratory was instrumental in 'fathering' the Australian Institute of Radiography.

tralian Institute of Radiography.⁷⁴ Dr Casey was also the first chairman of the Conjoint Board. But those events were in the future and occurred at a national level. It is opportune to return to the question of radiographic training in Queensland.

Mr Arthur Knight, for many years the chief radiographer at the Brisbane General Hospital, had commenced his career there in 1924 when training was arranged on an ad hoc basis. Mr Oscar Queitzsch was another whose radiographic career began shortly after the First World War. He was living in Atherton in north Queensland and was a keen amateur photographer. That interest brought him to the notice of Dr L.J.J. Nye, who was superintendent of the Atherton Hospital. In 1919 Dr Nye invited the young photographer to work at the hospital. His duties included operation of the X-ray apparatus. The association of these two men was to be a long one but it was soon to be severely tested. The local branch of the Returned Services League (of which Dr Nye was



FIG. 17. Mr Arthur Knight, senior radiographer at the Brisbane General Hospital. An ardent collector of early X-ray material some of which is housed in the Queensland Museum.

president) objected to the appointment because Oscar Queitzsch was a German. However, no Australian was either able or willing to do the work and the appointment stood. In 1930 Dr Nye founded the 'Brisbane Clinic' and Oscar Queitzsch conducted its X-ray department for the next thirty-two years.⁷⁵

The inaugural meeting of the Queensland branch of the ANZAR was held on 14 July 1939.⁷⁶ Members present were Drs Casey, Clarke, Heaslop, McDowall (chairman), Mason, Reye and Uhr. Dr Casey was empowered to organise a training course for X-ray technicians at a fee of 2 guineas per term. Lecturers in the various Part I subjects were Mr S.G. Kennedy of the Brisbane Grammar School (Physics and Chemistry), Mr H. Snape (Photography) and Dr E.W. Casey (Anatomy and Physiology). Twenty-six candidates sat for the Part I examinations. At a further branch meeting on 3 June 1940 lecturers were appointed for Part II of the course.⁷⁷ They were Mr D.F. Robertson (X-ray Physics) and Mr R.J. Lydon (Electrical Technology). As a surplus of almost £100 was present in the technicians' course

account it was decided that no fee would be charged for the Part II lectures. It was also decided that a payment of 10 guineas be made to Miss Marshall in recognition of her services concerning the formation of the Queensland branch of the ANZAR and the arrangement of lectures for the technicians' course. Alice Marshall's long association with the X-ray department at the Brisbane General Hospital will be fondly remembered by radiologists and radiographers who trained there during the 1940s and two subsequent decades.

The composition of the foundation Part I course has been described by Miss K.M. Hoffman:

'It was a big class with about five radiographers from the Brisbane Hospital X-ray department, six trained nurses from the Brisbane Hospital, two nuns from the Mater Hospital, one trained nurse from the Ipswich Hospital, three staff members from the Cancer Trust at the Mater Hospital and about six radiographers from Wickham Terrace rooms. It was to have been a two year course but because of the outbreak of war the time was reduced to about one year due to several members enlisting in the forces'.⁷⁸

The trainees in that pioneer course who had nursing experience were uniquely placed to bring skill and comfort to patients requiring radiotherapy for malignant disease.⁷⁹ Outstanding among them was Sister Clare Falconer.

Miss Rita Mundell has also written her recollections of the course and early radiographic career:

'I was amongst the first to sit for the X-ray Technicians' Examination in Queensland. We qualified in 1941. My certificate, issued by the ANZAR in association with the Melbourne Technical College, is dated 6.8.41 (No. 26).



FIG. 18. A Müller X-ray tube, circa 1901. This tube is one of a pair housed in the Queensland Museum. It was collected by the late Mr Arthur Knight.



FIG. 19. Mr Oscar Queitzsch at the Atherton hospital in the 1920s. The photograph illustrates that protective lead aprons and gloves were available but unfortunately were not uniformly used during fluoroscopic examinations in those years.

Amongst those who participated in the course were Arthur Knight, Jim Clarke, Bill Drover and Frank Lawton. At that time I was with Dr B.L.W. Clarke of Wickham Terrace and prior to the course had been engaged in Radiography for approximately ten years. I still remember the lead glass enclosed tube which used to make my hair stand on end in damp weather (literally); the old Bucky diaphragm, heavy as lead, hand set and string manipulated and the wind-up screening unit. I think I was born 50 years too soon!⁸⁰

Mr Roy Moss was another graduate of the first Queensland radiographic training course and his certificate was number 24. He remembers Sister Mary Rose from the Mater Hospital and Sister Joyce Tweddell as fellow graduates.⁸¹ His father, Mr Edward Moss, was a pioneer X-ray engineer who commenced his training at University College Hospital, London in the early 1900s. He came to Sydney prior to the First World War to establish a branch of Newton & Wright. After war service in Egypt as an X-ray technician he moved to Brisbane in 1923 as the representative of Watson & Sons and is remembered for his remarkable ability to install and service equipment under the most difficult conditions.

War with Germany began in September 1939 and with Japan in December 1941. It was to have profound effects on Queensland's X-ray personnel and services.

THE WAR YEARS

In 1940 Dr J.R. Adam was the radium and X-ray registrar at the Brisbane General Hospital. When Dr Casey enlisted in the AIF Dr Adam was the sole member of the full-time staff and carried the departmental workload until Dr A.G.S. Cooper arrived in December 1940 to act in Dr Casey's position.⁸² Dr Cooper had obtained the DMR (London) in 1938 and was practising in New Plymouth, New Zealand at the commencement of the war.⁸³ Although his interests were directed towards radiotherapy he shouldered an enormous diagnostic workload in Brisbane during the war years owing to the extreme shortage of radiologists. Drs Burnett Clarke and Clive Uhr and Sister



FIG. 20. Mr Oscar Queitzsch, immediately prior to his retirement after more than forty years of radiographic service.



FIG. 21. Dr Arthur Cooper, first director of the Queensland Radium Institute.

Joyce Tweddell were members of the ill-fated 8th Australian Division and became prisoners-of-war after the fall of Singapore on 15 February 1942. Ambrose Eltherington, another graduate of the first Queensland radiographic training course, also became a prisoner-of-war when Java fell in the following month. The shortage of radiologists in Brisbane was somewhat alleviated when Dr Casey's unit returned from the Middle East. He was released from the Army and directed to return to Brisbane.⁸⁴ Dr Jock Adam was called up for military service early in 1942 and was replaced as registrar by Dr Eileen Reimers. In addition to her radiological duties she also worked as a casualty officer and gynaecological resident.⁸⁵

The rapid advance of Japanese forces throughout the islands to the north of Australia resulted in Queensland becoming a major base for the Allied forces. The headquarters of General Douglas MacArthur, commander of the South West Pacific Area, were in Brisbane. Large numbers of American military personnel arrived and their radiological services were dislocated as a result of the wreck of the *Rufus King*, a liberty ship, on South Passage Bar between Moreton and North Stradbroke Islands in July 1942.⁸⁶ Included

in the cargo was X-ray equipment for three general hospitals. Although a considerable amount of other material was salvaged in perfect condition the X-ray equipment was contained in a hold breached by the sea and was either ruined or required extensive repair.⁸⁷ Dr Cooper responded readily to the American request for assistance and as a result of his contact and subsequent friendship with various American medical officers he obtained supplies of radioactive phosphorus and was the first to use that isotope clinically in Australia.⁸⁸

Restrictions on the availability of X-ray film and equipment for civilian purposes were stringently enforced during the war period. A proposed radiological installation at the Cairns Hospital was deferred in 1942 'until conditions in the north became more settled'.⁸⁹ Presumably this was a guarded comment referring to the possibility of Japanese invasion. Under the National Security Regulations it was necessary for operators of specified X-ray equipment to provide screening so



FIG. 22. Sgt Ambrose Eltherington photographed at Tel Aviv on 4 October 1941. He was a member of the 2/2 Aust. CCS, commanded by Lt-Col E.E. 'Weary' Dunlop and was captured by the Japanese at Bandoeng, Java on 8 March 1942.

Watson mobile (on 190 V. Supply)

Part	Pos	M.A.	Dist	Shut	Time
Wrist	A.P.	60	36	1	1 1/2
Elbow	A.P.	"	"	1	1 1/2
Shoulder	A.P.	"	"	2	1 1/4
Foot	A.P. & L.	"	"	1	1 1/4
Ankle	A.P.	"	"	1	1 1/2
Knee	A.P.	"	"	2	1 1/2
Hip	A.P.	"	"	3	2 1/4
Hand (Plaster)	A.P. & Lat	"	"	3	2 1/2
Chest	P.A.	"	48	2	1
Jaw	L	"	36	3	1 1/2
Teeth	A.P. & Lat	"	"	5	2 1/4
<u>With Bucky</u>					
Th. Spine	A.P. & Lat	60	30	5	5
L. Spine	A.P.	"	"	5	4
"	Lat.	"	"	7	8
Skull	A.P.	"	"	5	5
"	Lat	"	"	4	4
Sinuses	P.A.	"	"	6	5

FIG. 23. Photograph from Ambrose Eltherington's war diary showing exposure factors used at 1 Allied General Hospital Bandoeng, Java prior to its capitulation.

that emitted radiation did not interfere with wireless transmission.⁹⁰ Detailed specifications were issued to screen existing X-ray areas and even more elaborate ones were required for the small number of new installations proposed at that time.

In Toowoomba Dr Morris Beale was called up and the civilian radiological workload of the city and surrounding districts was carried by Dr Jim Bell, superintendent of the Toowoomba General Hospital.⁹¹ Also located in Toowoomba was the 117th Australian General Hospital and its commander, for some of the war period, was Dr Val McDowall.⁹²

The vicissitudes of war resulted in Dr Gordon Donnan commencing his radiological career in Brisbane. In November 1942 during the New Guinea campaign he lost his left arm. He was sent to the 112th Australian General Hospital at Greenslopes to recuperate. He described his decision to specialise in radiology as follows:

'On discharge from hospital and while the powers that be were deciding what to do with me I was sent to Goodna Mental Asylum to categorise service personnel held there. This I did indifferently with Professor "Bromide" Dawson's "Aids to Psychiatry" in my lap. I lacked the temperament to be a psychiatrist and chose radiology because of its large clinical content. Kenneth Fraser, then DDMS Northern Command, had Val McDowall assess my ability to handle the heavy fluoroscopy equipment of the day. In early 1943 Casey left the army to care for Clarke's and Uhr's practices and I took over from him at 112 AGH, knowing nothing about radiology. He was a great and loveable man. I still remember the first entity he showed



FIG. 24. The liberty ship *Rufus King* wrecked on South Passage Bar between Moreton and North Stradbroke Islands in 1942. Included in the cargo was a considerable amount of X-ray equipment for the American forces in Queensland. That equipment, although salvaged, was almost entirely ruined.



FIG. 25. An auto-radiograph of a fern leaf following its uptake of radioactive phosphorus. This photograph was given to Mr Arthur Knight by one of the American medical officers assisted by Dr Arthur Cooper following the loss of the *Rufus King*.

me — an osteochondritis dissecans of the femoral condyle'.⁹³

Despite the many difficulties and uncertainties of the war years a decision of momentous importance with regard to the treatment of those suffering from malignant disease in Queensland was implemented on 2 March 1944 when the Queensland Radium Institute (QRI) was formed.⁹⁴ The decision followed the visit of Drs Ralston and Edith Paterson to Australia in 1943.⁹⁵ Dr Ralston Paterson was the director of the Holt Radium Institute in Manchester and was a leading authority on cancer treatment. He visited Queensland and other Australian states after first advising the authorities in New South Wales who had invited him and his wife to Australia. His recommendations, contained in Appendix II, were accepted by the Queensland Government. At the first meeting of the QRI Dr Arthur Cooper was appointed radiotherapist-in-charge, a position he held until 1946 when he became the Institute's first director.

The functions of the X-Ray and Other Electro-Medical Equipment Advisory Board, formed on 1 May 1935, were absorbed by the QRI and the board ceased to function independently.⁹⁶ The absorption explains why subsequent decisions relating to the purchase of diagnostic X-ray equipment for public hospitals in Queensland were vested in the QRI which otherwise lacked involvement with diagnostic radiology.

The Queensland Medical School had been founded in 1936⁹⁷ and at a meeting of the Queensland branch of the ANZAR on 25 July 1945 the question of radiology lectures to medical students was discussed.⁹⁸ Dr G.W. Mason advised that he gave lectures every two years in anatomical radiology and a series of ten lectures to fifth and sixth year students. Dr McDowall advised the following meeting on 26 November 1945 that he had recommended to the faculty board that detailed radiological instruction for students was necessary and that an X-ray museum for teaching purposes should be established at the Brisbane General Hospital.⁹⁹ A resolution was passed at the same meeting expressing pleasure at the safe return of Drs Clarke and Uhr from their long period as prisoners-of-war.¹⁰⁰

The concluding years of the war also saw the conclusion of the first half century following Röntgen's discovery of X-rays. The post-war years witnessed many new faces and developments in the progress of X-ray services in Queensland. But that is another story.

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Numerous people assisted in this work. I owe special thanks to Mr Ray Dimmick, Mr John Gibbins, Drs David Cooper, Will Heaslop, John Masel, Morris Owen, Ross Patrick and John Sagar who revealed sources which otherwise would have remained unknown to me. Correspondents who have given lively illustration to past events include Drs Jim Bell, Gordon Donnan, Pat Flecker, Eileen Harrison, Miss Kate Hoffman, Miss Rita Mundell and Dr Fitz Vincent.

I am grateful to Mr Peter Carlile for the photograph of the glass X-ray plate and to Professor Brian Kruger for the photograph of the early dental X-rays. Mrs E. Queitzsch kindly allowed me access to her late husband's photographic collection and Miss Beryl Cook allowed publication of Dr Nisbet's letter to her mother. The Queensland branch of the Australian Medical Association provided the photographs of Sir David Hardie, Dr Wilton Love and Dr Val McDowall,

past presidents of the branch. Drs Pat Flecker and Michael Uhr provided the photographs of their fathers. Mr Mel Eltherington provided the photographs of his father and the radiographic exposure factors used at 1 Allied General Hospital in Java. Photographs of Drs Edward Casey, Burnett Clarke, Arthur Cooper and Tom Nisbet are from the archives and journals of the Royal Australasian College of Radiologists and that of Mr Arthur Knight from the Australian Institute of Radiography. Mr John Gibbins gave me the photograph, originally given to him by Mr Knight, showing the uptake by a fern of radioactive phosphorus. The editor of the Brisbane *Courier Mail* allowed publication of the photograph of the *Rufus King* and the photograph of Dr Walter Nisbet's X-ray room is from *Salute to the X-Ray Pioneers of Australia*.

Mr Graham Duryea of Sidney Riley, Brisbane prepared many of the photographs, Mrs Cathy McLennan and Miss Linet Welten typed the manuscript.

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APPENDIX I

Functions and Duties of The X-Ray and Other Electro-Medical Advisory Board
(from 1934-5 Annual Report of the Director-General of Health and Medical Services)

1. To report upon the standard of X-ray machines (including deep therapy machines) and equipment and other electro-medical and surgical equipment, which should be provided in the several public hospitals in the State, and organisation and staffing of X-ray departments.
2. (1) To prepare standard specifications and conditions of tender and contract for all X-ray and other electro-medical and surgical equipment for use in public hospitals, where such standard specifications have been prepared by an authoritative body in Australia or Great Britain. Where there are Australian standards, such standards shall be adopted and where there are no Australian standards, British standards shall be adopted.
- (2) To call all tenders for X-ray and other electro-medical and surgical equipment for use in public hospitals through the State Stores Board.
- (3) To report to the Minister upon all tenders received and to make recommendations thereon. In the consideration of tenders, the following matters shall be noticed and reported upon, namely:-
 - (i) General qualities of the several X-ray machines and accessory equipment tendered, or other electro-medical or surgical machines or equipment and accessory equipment.
 - (ii) In view of the fact that X-ray and

- electro-medical and surgical machines or equipment are usually provided by way of loan, the durability and robustness of the several machines or equipment tendered.
- (iii) Ease and rapidity of operation and performance of machines and equipment, and maintenance and operating costs.
 - (iv) Technical data required to be submitted in the tenders and rating claims made by the maker for the machines and equipment tendered, and in the case of X-ray machines as also declared upon the rating plates affixed to the machines, which rating plates shall contain declarations of rating required by the Australian Standard Specifications or British Standard Specifications, or where there are no Australian or British Standard Specifications, as required by the Specifications of the Board.
 - (v) Degree to which tenders have complied with the specifications, and whether non-compliance or a partial non-compliance with the specifications should disqualify any tender.
 - (vi) Tests which have been carried out by the Board, or which the Board has caused to be carried out in respect of the several machines or equipment tendered in accordance with tests prescribed in Australian Standard Specifications or British Standard Specifications, as the case may be, or where there are no Australian or British Standard Specifications, in accordance with tests specified by the Board, and to report the results of such tests and to report the order of merit and quality of each machine or equipment tendered as shown by the tests and to certify whether the declarations of the makers of the several machines or equipment have been established by such tests.
 - (vii) Having regard to the foregoing considerations, price and preferences as declared by the Government from time to time, to place the tenders in order of merit and value. In applying preference the Board shall report the country of manufacture of the machine or equipment tendered, and where the machine or equipment is not wholly manufactured in one country, the country or origin of the several component parts, and where the material from which the machine or equipment is manufactured is not produced in the declared country of manufacture, the country from which such material is obtained.

APPENDIX II

Report Concerning The Establishment Of The Queensland Radium Institute (from 1943-4 Annual Report of the Director-General of Health and Medical Services)

The Queensland Radium Institute was set up as a direct result of the visit to Queensland of Dr Ralston Paterson and Dr Edith Paterson (his wife), two recognised specialists in the organisation and application of radiotherapeutic treatment for cancer. Dr Ralston Paterson is the Director of the Holt Radium Institute of Manchester, and came to this country at the invitation of the Government of New South Wales, subsequently courteously accepting an invitation to visit Queensland and to advise the Government here as to the cancer problem within this state.

Dr Paterson emphasised the essential nature of the centralization of the control of treatment. He considered that it should be placed in the hands of full-time specialists devoting all their care and attention to the disease in some suitably situated central institution. He did not consider that the State itself was large enough to justify the establishment of a new and completely separate structure, but thought that a wing might be set aside at the Brisbane Hospital, within which the Queensland Radium Institute could set up its separate existence, working in conjunction with the Brisbane Hospital and other hospitals in this area in order that specialist radiotherapeutic treatment might be applied under the best of circumstances.

The fact that the whole of the Queensland population of 1 million people is spread over what is relatively a vast area, led to the further suggestion that treatment facilities should be instituted at hospitals sufficiently far from Brisbane to act as subsidiary centres. In these hospitals, the cases are first grouped by the local medical men for expert diagnosis. It is intended that visiting medical men from the permanent full-time staff of the Queensland Radium Institute shall visit these subsidiary centres

In the case of the British and Foreign machines or equipment, the certificate of the National Physical Laboratory, England, or a certificate recognised by the National Physical Laboratory, England, may be accepted.

regularly, and shall select from the patients brought to their notice all those who are likely to profit by treatment, either minor treatment which can be applied locally and immediately, or specialised expert treatment which can only be applied with the major facilities available in Brisbane under the control of the Queensland Radium Institute.

In order to facilitate treatment, anyone suffering from cancer who so requires it will be transported to Brisbane at the Government's cost; the treatment itself will be free.

Subsequently the Institute will extend its activities to include all forms of treatment for malignancy by arrangement with hospital organisations operating.

The Order in Council lays it down that the Institute shall co-operate with the hospitals in Brisbane, Rockhampton, Mackay, Townsville, Cairns and Toowoomba, and shall co-ordinate the organisations for the treatment of the sick established at these places. The hospital boards and the management of corresponding hospitals or institutions concerned are required by the Order to

co-operate also with the Queensland Radium Institute.

Provision is made not only for public, but for intermediate and private patients, and the control is placed in the hands of a body consisting of a chairman, a deputy chairman, and seven additional members, representative of the Brisbane and South Coast Hospitals Board, the Queensland Cancer Trust, the University of Queensland, the Queensland Branch of the British Medical Association, and a representative of the Mater Misericordiae Hospital.

The activities of the institute commenced with its first meeting on 12th April 1944.

It was considered appropriate that the activities of the X-ray and other Electro-Medical Equipment Advisory Board, which extended to the supervision of the provision of all X-ray apparatus to public hospitals, etc., their care, maintenance and servicing, should be one of the functions of the Queensland Radium Institute. The transfer of all papers and particulars has accordingly been made.

PARANAUPHOETA RUFIPES BRUNNER IN QUEENSLAND, AND A DESCRIPTION OF
THE FEMALE CALOLAMPRA ELEGANS ROTH AND PRINCIS (DICTYOPTERA :
BLATTARIA : BLABERIDAE).

LOUIS M. ROTH

Roth, L.M. 1989 11 13: *Paranauphoeta rufipes* Brunner in Queensland, and a description of the female *Calolampira elegans* Roth and Princis (Dictyoptera : Blattaria : Blaberidae). *Mem. Qd Mus.* 27 (2): 589–597. Brisbane. ISSN 0079–8835.

Paranauphoeta rufipes Brunner is reported from Cape York Peninsula; it also occurs in New Guinea, Sumatra, Java, and the Moluccas. This species is polymorphic and varies in colour and size. *Paranauphoeta discoidalis* (Walker) is a variant and synonym of *rufipes*. The previously unknown aposematic female of *Calolampira elegans* Roth and Princis is described. □ *Blaberidae*, *Paranauphoeta rufipes*, *Calolampira elegans*, *Queensland*.

Louis M. Roth, Museum of Comparative Zoology, Harvard University, Cambridge MA, 02138, U.S.A.; Correspondence: Box 540, Sherborn, MA, 01770, U.S.A.; 29 July, 1988.

In this paper I give the diagnostic characters for the genus *Paranauphoeta* Brunner and redescribe *Paranauphoeta rufipes* Brunner which has been reported from New Guinea (Irian Jaya and Papua New Guinea), Waigeo, Moluccas, Java, and Sumatra. Additional material, reported here, extends its range to Australia (it was previously reported, identified to genus only, from Shelburne Bay and Iron Range, Queensland, by Kikkawa *et al.*, 1981: 1716, table 3). I also describe the previously unknown female of *Calolampira elegans* Roth and Princis.

Specimens were borrowed through the kindness of the following museums, and their curators: ANIC — Australian National Insect Collection, Canberra, Australia; Dr D.C.F. Rentz. BMNH — British Museum (Natural History), London, England; Mrs J. Marshall. HDEO — Hope Department of Entomology, Oxford, England; Dr G.C. McGavin. MCZH — Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA. NMWA — Naturhistorisches Museum Wien, Vienna, Austria; Dr Ulrike Aspöck. QMBA — Queensland Museum, Brisbane, Australia; Dr G.B. Monteith. RNHL — Rijksmuseum van Natuurlijke Historie, Leiden, The Netherlands; Dr J. van Tol. ZILS — Zoological Institute, Lund, Sweden; the late Dr Karlis Princis.

***Calolampira elegans* Roth and Princis**
(Fig. 1A)

Calolampira elegans Roth and Princis, 1973, p. 103.

MATERIAL EXAMINED

QUEENSLAND. QMBA: 1 ♀, Capella, P.C. Allan, 10.iii.1938 (labelled; Fam. Blaberidae, gen. and sp. nov., M.J. Mackerras, determined; also with an older label '*Cosmozosteria* sp.').

DESCRIPTION

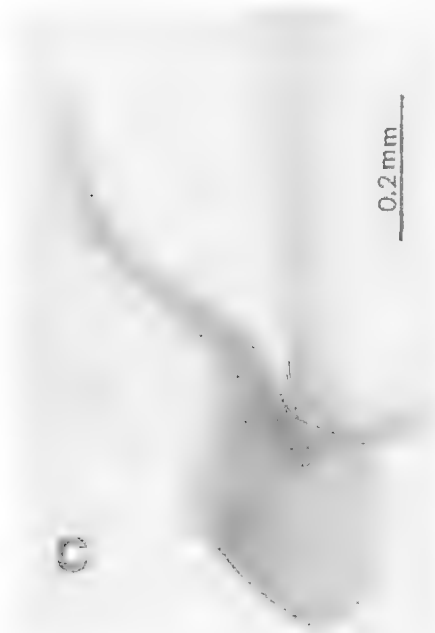
FEMALE. Habitus shown in Fig. 1A. Strongly convex. Tegmina and wings absent. Head hidden under pronotum, face flat with few spaced punctations, genae rugulose; eyes wide apart, the interocular space about the same as distance between antennal sockets. Thorax sparsely punctulate; pronotum parabolic. Abdominal terga sparsely punctulate, punctations more distinct on T1–T4, posterolateral angles not produced; supraanal plate transverse, semicircular. Cerci short, not reaching beyond hind margin of supraanal plate. Last abdominal spiracle conical, dorsal at base of cercus. Front leg: anteroventral margin of femur with 3 large spines on basal half, followed by several well spaced minute, piliform spinules, terminating in 1 small heavy spine, posteroventral margin with 0 or 1 spine distad, plus a large terminal spine, genicular spine absent; proximal 4 tarsomeres with pulvilli occupying their entire ventral surfaces, fifth tarsomere with a narrow median line the same colour as the pulvilli, occupying the full length of the segment. Mid leg: anteroventral margin of front femur with 3 large spines plus a distal spine, posterior margin with 1 or 2 spines plus a distal spine, genicular spine present; pulvillus on first tarsomere reaching to about middle of segment, followed by a short double row of small spines, pulvilli on tarsomeres 2–4 occupy their entire ventral surfaces, these without a row of spines. Hind leg: anteroventral margin of femur with 3 large spines plus a distal spine, hind margin unarmed, genicular spine present; pulvilli on first and second tarsomeres apical, preceded by a double row of small spines that extend the full length of the segment, remaining 2 pulvilli as in front and mid tarsi. On all legs, tarsal claws large, simple, symmetrical,

**A**

10mm

**B**

5mm

**C**

0.2mm

**D**

0.2mm

arolia subobsolete (region between bases of claws swollen, but not extended).

Colouration: Head black with a narrow interocular yellow band on top, ocelliform spots small, yellow, lower border of labrum, and clypeus, reddish. Pronotum yellow, margins black, with a large dark macula on disk. Meso- and metanotum black with lateral, yellow, tegmina-shaped markings; hind margin of mesonotum with a pair of indistinct, widely separated reddish spots, larger yellowish spots in a similar position on hind margin of metanotum. Abdominal terga black, yellow, and red, as follows: T1 black; T2 mostly black with lateral yellow borders, the colour tapering to hind margin of segment, a faint indication of red near the lateral anterior margin; amount of red and yellow increases on T3, and more so on the remaining segments so that the black is largely replaced by red, and the yellow runs the full width of the hind margin of T7; basal half of supraanal plate black, followed by yellow, hind border regions sprinkled with black. Abdominal sterna mostly red with hind and lateral borders black, subgenital plate with distal half black. Dorsal surface of cerci yellow, ventrally dark. Legs black, pulvilli yellow; outer edge of front coxae reddish black, those of mid and hind coxae yellow.

Measurements (mm): Length, 34.0; pronotum length \times width, 9.4×14.5 .

REMARKS

Calolampra elegans differs from all other species of the genus in lacking tegmina and wings in both sexes. It also is the only *Calolampra* with aposematic colouration, and superficially resembles some coloured species of Polyzosteriinae (hence the old '*Cosmozosteria*' label on the specimen). The unique apterous and aposematically coloured holotype male (from Peak Downs, Queensland, in Stockholm Museum) is smaller than the female (length, 23.0 mm, pronotum length \times width, 7.0×10.0 mm) (Roth and Princis, 1973: 105). Capella and Peak Downs are only 15 km apart in the Central Highlands of Queensland.

FIG. 1. A, *Calolampra elegans* Roth and Princis, female from Capella, Q., habitus. B-D, *Paranauphoeta rufipes* Brunner, males, habitus, and genital phallomeres L2d (at apex of L2vm), and R2. B and C locality unknown, D, from Mt Missim (Papua New Guinea).

Paranauphoeta Brunner

Paranauphoeta Brunner, 1865, p. 397; Saussure and Zehntner, 1895, p. 15; Hanitsch, 1915, p. 137. Type-species: *Paranauphoeta circumdata* (Hahn) (= *Blatta/Nauphoeta circumdata* Hahn, 1842, p. 52), selected by Rehn, 1904, p. 558.

DIAGNOSIS

Tegmina and wings fully developed; about basal half of tegmina with punctations between the veins; hind wing and subcosta extending to about middle of wing, costal veins subobsolete or obsolete, costal vein area narrow, coriaceous; median vein simple, cubitus vein with complete and incomplete branches, apical triangle small or absent (Fig. 2I). Anteroventral margin of front femur with a short row of piliform spinules on distal third or less, without long proximal or terminal spines (there may be a single minute stout terminal spine, shorter than a piliform spinule) (Type C), hind margin with only a minute apical spine; front and hind margins of mid and hind femurs without spines or piliform spinules; genicular spine absent from front femur but present on mid and hind femurs; front tibiae with a large dense brush of setae on ventral margin; pulvilli present on 4 proximal tarsomeres of all legs, tarsal claws symmetrical, simple, arolia essentially subobsolete (they do not extend below the bases of the claws, and probably are non-functional). Male: Abdominal terga unspecialized. Subgenital plate weakly asymmetrical bearing widely separated similar, cylindrical styles; in most species the margin of the plate behind the right style is excavated and its posterior corner is sharply produced (Fig. 2D,a). Genitalia with 3 principal phallomeres, as in Fig. 2C,D: hooklike phallomere (R2) on right side, robust, with a distinct subapical incision (Fig. 1D); median phallomere (L2vm) rodlike, with a distinctive sclerite (L2d), separated from its apex by a membrane (Fig. 1C).

REMARKS

Princis (1964: 248–251; 1971: 1141) listed 15 species of *Paranauphoeta*, most of them occurring in parts of Asia and Indonesia. The present record of *P. rufipes* extends the known range of the genus to the Australian continent.

The small toothlike projection on the subgenital plate behind the right style is generally characteristic of the genus; it is absent in *Paranauphoeta nigra* Bey-Bienko (Bey-Bienko, 1969, fig. 14; 1970, fig. 14). The subgenital plate of some species of *Perisphaeria* also have a single toothlike projection on the right side (see McKittrick, 1964, pl. 48,

fig. 130E). The subgenital plates of genera of Oxyhaloinae (*Nauphoeta*, *Leucophaea*, *Henschoutedenia*, *Jagrehnia*, *Gromphadorhina*) resemble those of *Paranauphoeta* but they have a spine-like projection behind the right and left styles (see Roth, 1971, figs 2–5).

I have examined the male genitalia of 6 species of *Paranauphoeta* and phallomere L2d (Fig. 1C) is a good distinguishing character in some taxa and possibly could be used for determining relationships between them. The right and left phallomeres are similar in the several species I studied.

Because the pronotal markings of *Paranauphoeta rufipes* are similar to those of *Proscratea complanata* (Perty), Saussure and Zehntner (1895: 16) stated that *Paranauphoeta* is the 'Asiatic counterpart' of *Proscratea* (South America). The similarity between the two genera is superficial. The male genital phallomeres R2 and L2d of *Proscratea complanata* (see Roth, 1973, figs. 46–57) differ markedly from those of *Paranauphoeta* and it belongs in the Pycnoscelinae (Roth, 1973: 256). Princis (1964: 231, 248) placed *Paranauphoeta* in the Perisphaeriinae.

***Paranauphoeta rufipes* Brunner**
(Figs. 1B–D, 2A–I, 3A–L)

Paranauphoeta rufipes Brunner, 1865, p. 400 (♂ ♀); Walker, 1869, p. 122; 1871, p. 5; Saussure, 1872, p. 154; Tepper, 1894, p. 189; Saussure and Zehntner, 1895, p. 16; Brunner, 1898, p. 198; Krauss, 1903, p. 746; Kirby, 1904, p. 180; Karny, 1915, p. 94; Hanitsch, 1923, p. 212; Karny, 1925, p. 190, t. col. fig. 11; Hanitsch, 1931, p. 58, pl. 1, fig. 6 [habitus]; Bruijning, 1947, p. 240; 1948, p. 158; Princis, 1964, p. 251.

Paranauphoeta rufipes var., Saussure, 1872, p. 154.

Paranauphoeta saussurei Karny, 1915, p. 94 (name applied to Saussure's *Paranauphoeta rufipes* var.); Princis, 1958, p. 72 [synonymized with *Paranauphoeta discoidalis* (Walker)].

Paranauphoeta rufipes var. *novae-guineae* Bolívar, 1898, p. 138; Kirby, 1904, p. 180 (synonymized under *Paranauphoeta discoidalis*); Karny, 1915, p. 94, footnote 3 (synonymized with *discoidalis*); Hanitsch, 1923, p. 212 (synonymized with *P. rufipes*); Princis, 1964, p. 251 (stated that Kirby's synonymizing under *discoidalis* was incorrect).

Nauphoeta discoidalis Walker, 1868, p. 39; Tepper, 1893, p. 117.

Paranauphoeta discoidalis (Walker): Kirby, 1904, p. 180; Karny 1915, p. 94; Hanitsch, 1931, p. 58 (synonymized under *P. rufipes*); Princis, 1958, p. 72; 1964, p. 251 (listed *discoidalis* and *rufipes* as distinct taxa).

MATERIAL EXAMINED

LECTOTYPE: Male, Ternate (Moluccas), Mus. Caes. Vind.; in the NMWA, here designated.

PARALECTOTYPES: Ternate. NMWA: 1 ♂ (terminalia slide 51), Deyrolle, col. Br. v. W.; same data as lectotype, 3 ♂.

ADDITIONAL MATERIAL: NEW GUINEA. BMNH: "Dorry", ♀ lectotype (selected by Princis, 1958, p. 72) of *Nauphoeta discoidalis* Walker; 1 ♀ paralectotype of *discoidalis*; "Bubia Lae", 1 ♂, 1 ♀, in native garden, 11.iii.1957, J.H. Ardley. HDEO: "Dor." (probably Dory), 1 ♂ (terminalia slide 226), Wallace; "Bac." (?Batchian), 1 ♀, Wallace; 1 ♀, Wallace. RNHL: 1 ♀.

PAPUA NEW GUINEA. BMNH: East Highland district Watanabe Valley, near Okapa, c. 5000 ft., 1 ♀, 5.ii.1965; Maprik, 1 ♂, 1 ♀, 24.x.1957, J. Smart; Popondetta Dist., Sangara, 1 ♀, 22.iii.1956, E.S. Brown; "Bisi Ptn", N. District of Papua, 1000 ft., 1 ♂, 21–23.?.1964, J.J.H. Szent-Ivany and C. Mayoh; Papua "Mafulu", 4000 ft., 1 ♀, i.1934, L.E. Cheesman; Kokoda, 1200 ft., 1 ♂, viii.1933, L.E. Cheesman. HDEO: Aru, 1 ♂ (terminalia slide 225), Wallace; Astrolabe Geb., British New Guinea, 1 ♂ (terminalia slide 224), presented by Brussels Natural History Museum (labelled var. *novae-guineae* Bol.; determined as *Paranauphoeta rufipes* Brunner by Shelford, 1908; this specimen was mentioned by Hanitsch, 1923, p. 212, and he stated that its colour was pale and washed out). MCZH: Mt. Missim, Morobe District, New Guinea, 1 ♂ (terminalia slide 63), Stevens; Morobe District, 1 ♂, 4 ♀, Stevens.

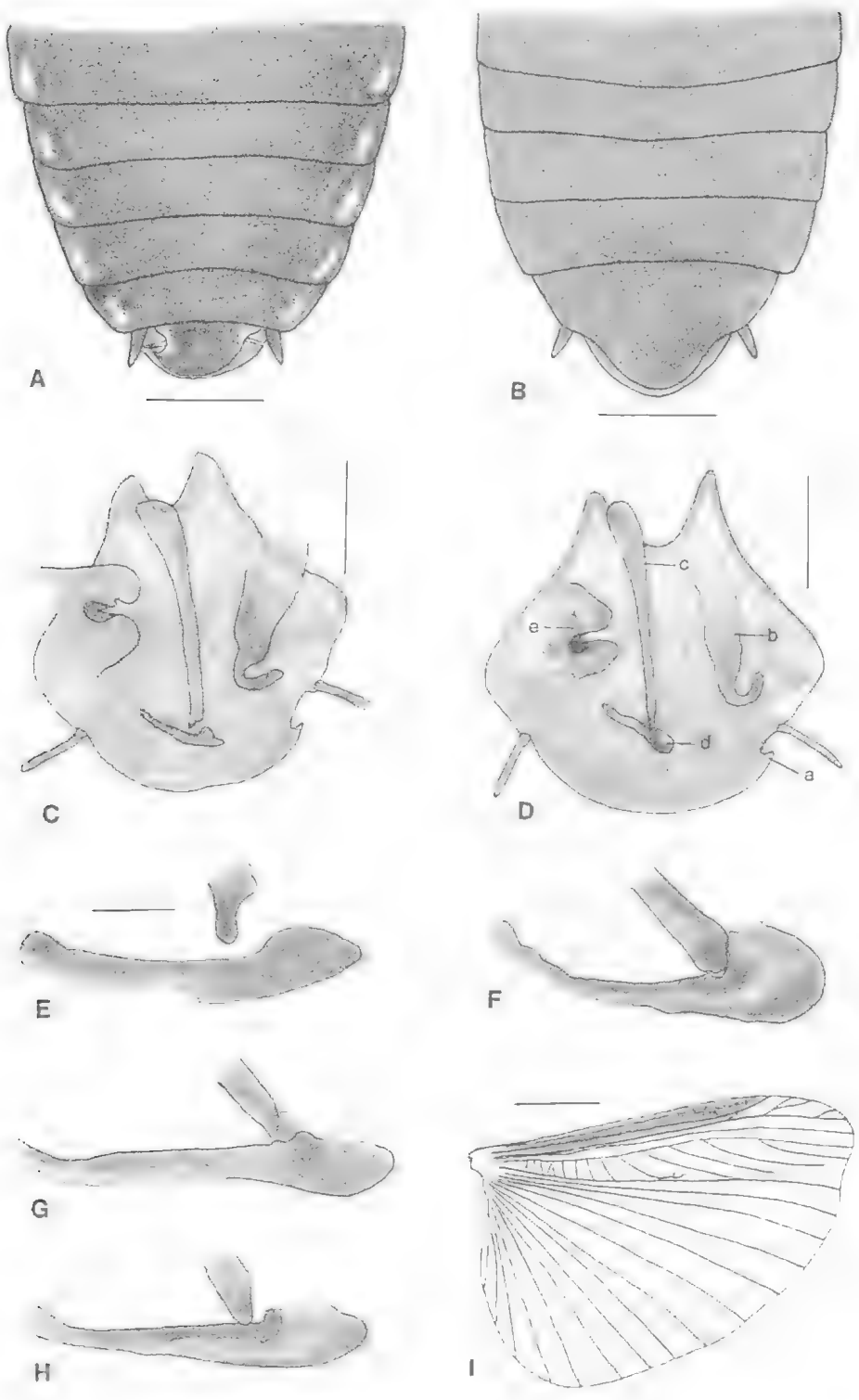
IRIAN JAYA (= NETHERLANDS NEW GUINEA). BMNH: Waigeo (= Wagiou, Waigiou; an island belonging to and off the northwestern coast of Irian Jaya), 1 ♀ paralectotype of *N. discoidalis*. HDEO: "Wag." (= Waigeo), 1 ♀, Wallace E. coll. (1830–73), W.W. Saunders, purchased and presented '73 by Mrs F.W. Hope. RNHL: Fakfak, 1 ♂ (terminalia slide 149), 1 ♀, C.J. Palmer; 1 ♀, Netherlands New Guinea Exped., 1911, Dr P.N. van Kampen; Sekroe, northwest New Guinea, 1 ♀, acquired 1898, K. Schädler; "Tor Rivier", N. Nw. Guinea, Berkomba, 2 ♀, 17–20.x.1911.

NEW BRITAIN. BMNH: 1 ♀, Reg. Mar. 98, A. Willey.

MOLUCCAS. BMNH: 1 ♂ (terminalia slide 31). MCZH: Halmahera, 1 ♀, T. Barbour (determined by Ashley Gurney, 1948).

JAVA. RNHL: 2 ♀, W.J.E. Hekmeyer.

FIG. 2. *Paranauphoeta rufipes* Brunner. A, male paralectotype from Ternate, abdominal sterna; B, female from New Guinea, abdominal sterna; C, male paralectotype from Ternate, subgenital plate and genitalia (dorsal); D, male from Astrolabe Mt (Papua New Guinea), subgenital plate and genitalia (dorsal); a = toothlike projection on right side of subgenital plate; b = sclerite of the right phallomere R2; c = median sclerite (L2vm); d = dorsal sclerite of left phallomere (L2d); e = L1 sclerite of left phallomere. E–H, male genital phallomeres L2d at apex of L2vm; E, paralectotype from Ternate; F, from Gordon's Mine Area, Iron Range, Q.; G, from New Guinea; H, from Aru (Papua New Guinea). I, female paralectotype, hind wing. Scales (mm); A, B, 3.0; C, D, 1.0; E–H, 0.2; I, 4.0.



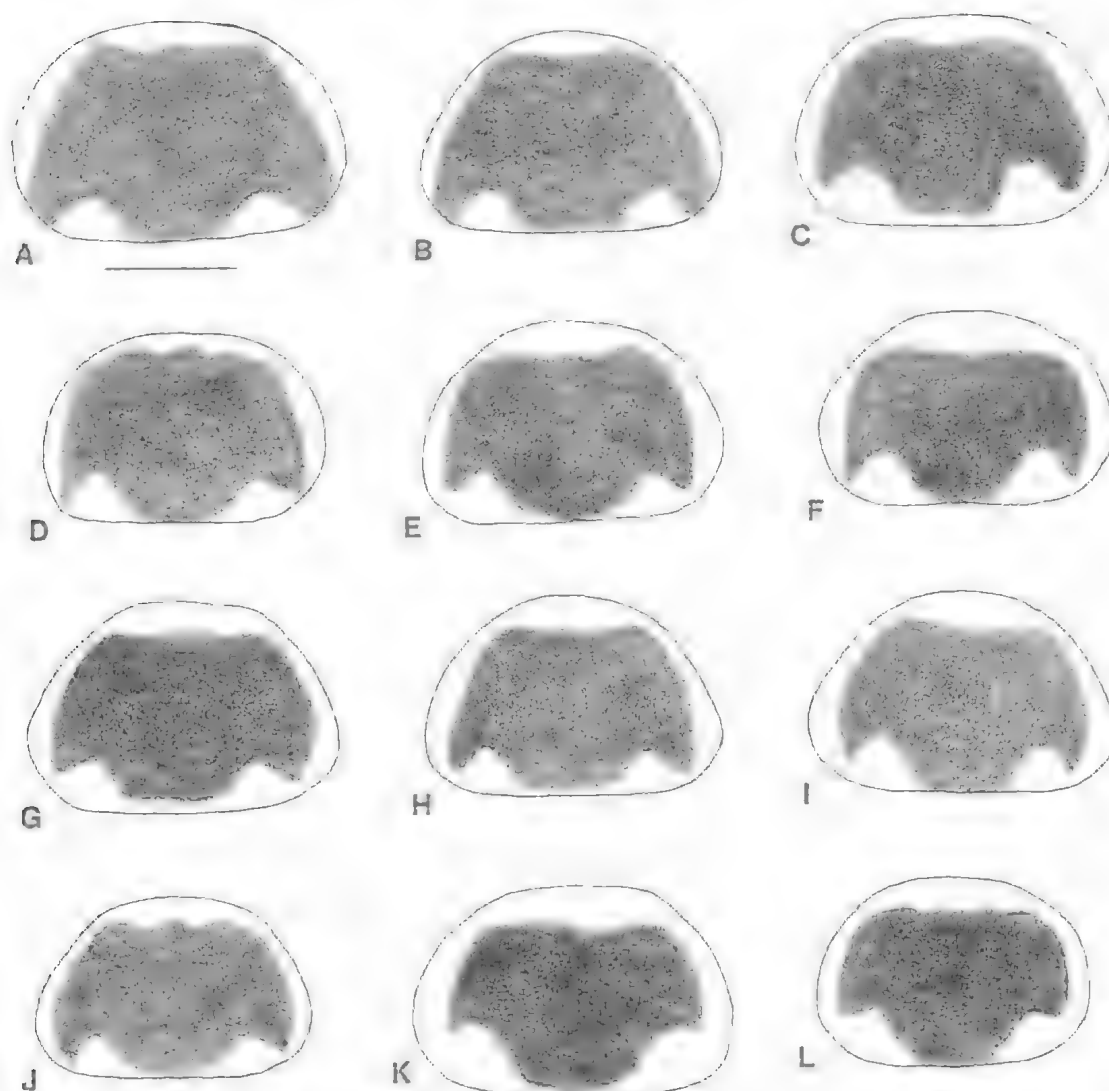


FIG. 3. *Paranauphoeta rufipes* Brunner, pronota: A, female paralectotype from Ternate; B, female from Java; C, female from Halmahera; D, female from Irian Jaya; E, female from New Guinea; F, male from Astrolabe Mt. (Papua New Guinea); G, female from Waigeo, Irian Jaya; H, male from Mt Missim (Papua New Guinea); I, male from Fak, Fak, Irian Jaya; J, female from Sekroe, northwest New Guinea; K, female from 3 km ENE of Mt Tozer, Q.; L, female from 11 km ENE of Mt Tozer. Figs A-C are *rufipes*-like specimens, all others are *discoidalis*-like forms. Scale = 3 mm.

QUEENSLAND. ANIC: The following were collected by D.C.F. Rentz; 3 km ENE of Mt Tozer, nr Iron Range N.P., 12.44S 143.14E, Stop 1-3, 1 ♀, 28.vi.1986; 11 km ENE of Mt Tozer, nr Iron Range, N.P., 12.43S 143.18E, Stop 1-20, 1 ♀ (on tree trunk), 11.vii.1986. QMBA: The following were collected by G.B. Monteith: Dividing Range, 15 km W of Captain Billy Creek, Cape York Pen., 11.40S 142.45E, 1 ♂, 5-12.ji.1976, 1 ♀, 4-9.vii.1975; Gordon's Mine Area, Iron Range, rainforest, 2 ♂ (1 with terminalia slide 71), 1 ♀, 12-18.xii.1976. The following were collected by G.B. Monteith and D. Cook:

Packers Creek, via Portland Road, Pyrethrum knockdown/RF, 1 ♀, 6.xii.1985; West Claudie R., Iron Range, rainforest, 50 m, 1 ♂, 3-10.xii.1985.

No locality data, ZILS: 1 ♂ (terminalia slide 1446), Fried. Wilhelmshafen (labelled *Paranauphoeta saussurei* Karny, by Princis).

DESCRIPTION

MALE. Interocular distance greater than inter-ocular space. Pronotum with anterior margin rounded, hind margin practically straight, lateral

margins convex, widest behind the middle (Fig. 3). Tegmina and wings fully developed reaching to end of abdomen or slightly beyond. Cubitus vein of hind wing with 1–2 complete and 2–4 incomplete branches, apical triangle essentially absent (Fig. 2I). Abdominal terga unspecialized. Supraanal plate transverse, hind margin convexly rounded, reaching hind margin of subgenital plate. Subgenital plate weakly asymmetrical, styles similar, elongated, slender, cylindrical, widely separated, inter-stylar margin convexly rounded with a small toothlike projection posterior to the right style (Fig. 2D). Anteroventral margin of front femur with a row of piliform spinules (Type C) (there is a minute distal or terminal spine, smaller and heavier than a piliform spinule, which could be considered a subobsolete spine [Type C₁]), arolia subobsolete or absent. Genitalia as in Fig. 2C, D; L2d at apex of L2vm enlarged basally (Fig. 1C, 2E–H).

FEMALE. Supraanal plate broadly rounded. Subgenital plate with margin below cerci concavely excavated, hind margin rounded and fitting closely to the rounded hind margin of the subgenital plate.

Colouration: Head black or dark reddish brown, labrum reddish and yellowish brown, lower half of clypeus and small ocellar spots yellowish. Antennae with basal segments (about 13) shiny, smooth, dark brown or black, remainder hirsute, dull brown. Pronotum with a large brownish black, reddish brown, or black macula which may vary in shape so that the amount of the surrounding pale area (yellow or white) differs; the posterior half of the dark macula is indented with the lateral corners often produced forming a complete or incomplete triangular spot on each side (Figs 3A–L). Left tegmen dark brown, reddish brown, or black with a large yellow, yellowish white, or white macula on basal half of axillary veins, a smaller similarly coloured spot at about the middle, distal region hyaline, veins dark brown; basal half of costa yellow or white, costal veins broadly and irregularly outlined with brownish black or black, the spaces between them yellowish or white, marginal field brownish black or black; that portion of right tegmen covered by the left is hyaline and colourless, the veins in that region mostly dark brown, otherwise with markings similar to the left tegmen. Hind wing not infuscated, costal vein region light or dark brown, veins dark brown. Abdominal terga brown or reddish brown, anterior segments lighter, with broad yellow or whitish yellow lateral borders. Supraanal plate with a dark macula on posterior half, or basally. Abdominal sterna dark

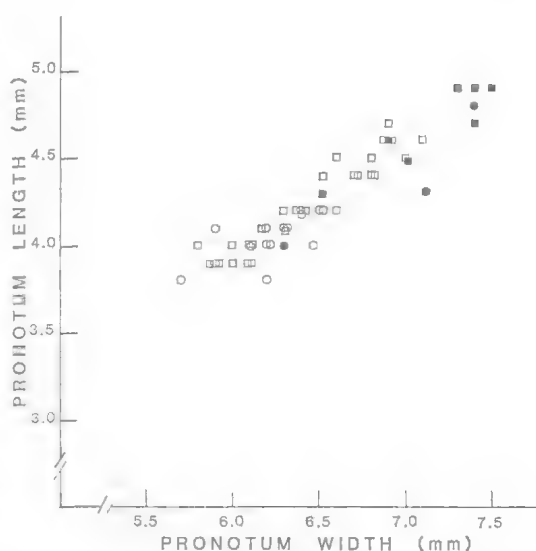


FIG. 4. Pronotal size of *Paranauphoeta rufipes* Brunner. Solid symbols = *rufipes*-like morphs; open symbols = *discoidalis*-like morphs. Circles = males, squares = females.

brown or reddish brown, or black, without markings (Fig. 2B), or with narrow, elongated, yellow, lateral maculae (Fig. 2A). Coxae and femurs dark brown, tibiae and tarsi reddish, or rarely coxae dark brown, femurs, tibiae, and tarsi reddish. Cerci dorsally yellowish or reddish brown with darker basal segments, ventrally dark brown.

Measurements (mm) (♀ in parentheses). Length, 16.8–25.7 (17.7–26.0); pronotum length × width, 3.8–4.8 × 5.7–7.4 (4.0–4.9 × 5.8–7.5); tegmen length, 15.5–20.1 (15.4–21.3). (see Fig. 4).

REMARKS

Karny's (1915: 94) key to species of *Paranauphoeta* was based almost solely on colour of pronotum, tegmina, and legs; among the 17 species in the key were *P. saussurei* (the name he applied to *P. rufipes* var. *Saussure*), *discoidalis*, and *rufipes*. Although colour markings are useful in distinguishing many species of *Paranauphoeta*, I believe that the above 3 species are one taxon, *rufipes*, which is polymorphic for colour. The light areas usually are yellow with some spots whitish yellow, rarely predominantly white. The lecto- and paralectotypes of *rufipes* and females from 'Bac.', 2 from Java, and 1 from Halmahera have lateral yellow spots on the sterna (Fig. 2A; *rufipes*-like morph); all of the others lack sternal spots (Fig. 2B; *discoidalis*-like morph). One female from near Okapa, Papua New Guinea, has very weak indications of lateral sternal spots. The relatively few specimens available for measurement suggests that

the *rufipes*-like morph might be larger than the *discoidalis* form but their pronotal sizes distinctly overlap (Fig. 4). The male genital phallomere L2d of *discoidalis* is essentially similar to that of *rufipes* when variation in that structure is considered (Figs. 1C, 2E-H).

The Australian morph is *discoidalis*-like but 2 females from 3 and 11 km ENE of Mt Tozer have the dark areas black and the light regions white (pronotum, tegmina, and abdomen); the coxae are black, femurs blackish brown, and tibiae and tarsi reddish. The other morphs from Queensland and elsewhere have the more typical yellowish pale areas, and reddish brown or dark brown dark areas. The genital phallomere L2d of the male from Queensland (Fig. 2F) is similar to the one shown in Fig. 1C.

According to Monteith (pers. comm.), *Paranauphoeta rufipes* '... has a very restricted distribution in Australia, being found only in the rainforests of the central part of Cape York Peninsula. Almost all known specimens come from the Iron Range region, which P.J. Darlington designated the "mid-peninsula" zone in his zoogeographic analysis of the Australian rainforest carabids. It also occurs a little further north at Shelburne Bay (Captain Billy Creek), but interestingly, not at the tip of the Peninsula'.

Brunner's types of *rufipes* came from Ternate (Moluccas). The species has also been recorded from Sumatra and Java (Princis, 1964: 251). Princis gave the localities for *Paranauphoeta discoidalis* Walker as New Guinea and Waigeo, the type localities of the species. He did not list *rufipes* from New Guinea although some of his references listed under this species were those of Hanitsch and Bruijning both of whom considered *discoidalis* a synonym of *rufipes*, and listed the species from Irian Jaya and Papua New Guinea. Princis gave no reason for not accepting this synonymy. Princis (1958: 72) used the presence of the pair of triangular yellow spots in the posterolateral corners of the pronotal macula to distinguish *discoidalis* from *circumdata*, but he did not compare this pattern with *rufipes*. Although Princis claimed that these triangular spots are always present in *discoidalis*, this is not true. In his description of *P. rufipes*, Brunner stated that the form, colour, and outline of the pronotal disk macula were identical to those of *Proscratea complanata* (a South American genus and species). The macula on the pronotum of *complanata* is variable and there may or may not be a pair of pale triangular lateral spots (see Roth, 1973, figs 40-42). The pronotal pattern in *Paranauphoeta rufipes* is similarly variable (Fig.

3). I agree with Hanitsch and others who believed that *discoidalis* is a synonym of *rufipes*.

ACKNOWLEDGEMENTS

I thank Dr G.B. Monteith for the female of *Calolampra elegans*, and Dr Frank Carpenter, of Harvard University, for taking its photograph. I am grateful to the curators and individuals mentioned earlier who sent me specimens, and the Australian Biological Resources Study for partial support.

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A REVIEW OF THE HISPINE TRIBE APROIDINI (COLEOPTERA: CHRYSOMELIDAE)

G. A. SAMUELSON

Samuelson, G.A. 1989 11 13: A review of the hispine tribe Aproidini (Coleoptera: Chrysomelidae). *Mem. Qd Mus.* 27(2): 599-604. Brisbane. ISSN 0079-8835.

Three species of *Aproida* Pascoe comprise the Aproidini, a tribe restricted to Australia. The third species is described herein as new. All three are keyed and illustrated.

□ *Aproida*, *Aproidini*, *Australia*, *Chrysomelidae*, *biosystematics*, *distribution*, *key to species*.

G. A. Samuelson, Bishop Museum, PO Box 19000-A, Honolulu, Hawai'i, U.S.A.; 20 October, 1988.

The Aproidini is a small tribe of Hispinae comprising only one genus, *Aproida* Pascoe, 1863, which is restricted to northeastern Australia. A third species is now added to *Aproida*. Material for this study was obtained from the following sources: AMSA = Australian Museum, Sydney; ANIC = Australian National Insect Collection, CSIRO, Canberra; BPBM = Bishop Museum, Honolulu; NSW = Biological and Chemical Research Institute, Rydalmere; QMBA = Queensland Museum, Brisbane; SAMA = South Australian Museum, Adelaide; JS = Josef Sedlacek, Brookfield.

Measurements of body length and breadth are rounded to the nearest 0.5 mm; other measurements are taken to the nearest 0.01 mm.

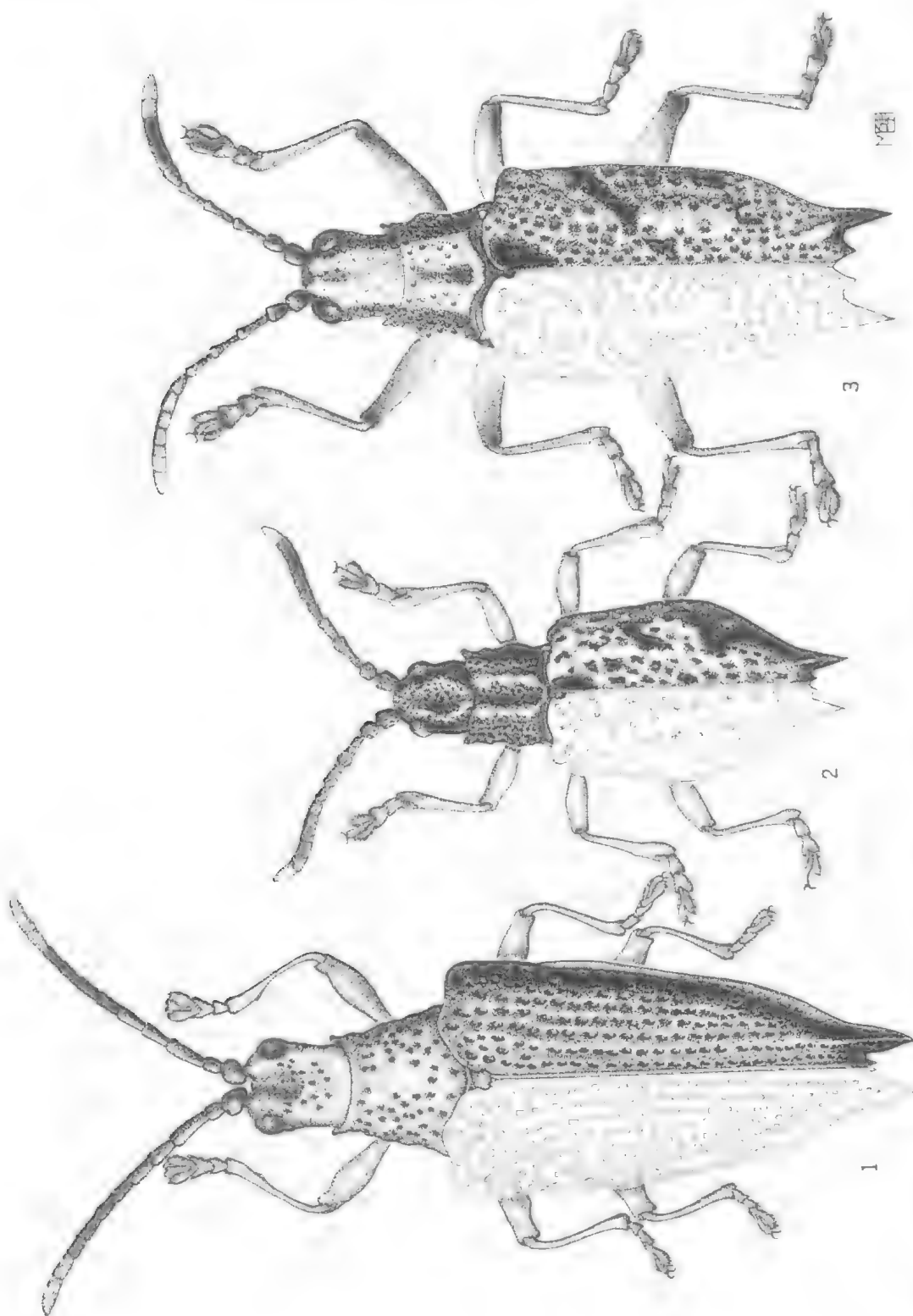
Aproidini Weise, 1911

Body form somewhat navicular, narrowed anteriorly and posteriorly. Head elongate; front vertical, concave or flattened between antennal insertions; antennal base placed a short distance above mouth, lower part of antennal base with short vertical keel; genal margin of mouth produced as a keel; eye finely faceted. Prothorax without lateral margins and lacking lateral spines; anterior angle with associated pore and seta; posterior angle lacking pore and seta. Elytron with short postscutellar puncture row present, though not always conspicuous; discal puncture rows basically regular but tending to become irregular to confused; elytral apex acute, spined.

The usual body plan in Hispinae tends to be depressed, though the form can range from elongate to stout. Even the linear, more or less cylindrical Eurispini have the abdomen distinctly depressed. The two flighted species of *Aproida* depart from this plan in a slightly compressed, deep body, even though the dorsal surface is flattened along the elytra. This unusual form is best seen in lateral view and it perhaps bears a

resemblance to certain Orthoptera. The brachypterous species, *A. cribrata* Lea, is shallower in the body and has the elytra more convex dorsally.

Weise (1911) based the tribe on the then unique *Aproida balyi* Pascoe. On the basis of tribal keys by Weise (1911) and Würmli (1975), the Aproidini and Anisoderini appear to be the most closely related, but further studies are needed to tell whether they actually are. They are separable on eye facetting, with the former having fine facets with a nearly smooth eye surface and the latter having coarse, swollen facets forming a bumpy surface. The Anisoderini is Oriental and contains three genera with about 75 species, but it does not reach Australia. Weise (1911) provided no special discussion on the affinities of *Aproida*, other than indicating a similarity in the form of the head and thorax to *Exothispa* from Africa. The latter represents the Exothispini, and it appears distant from the Aproidini, as it falls with the tribes lacking the short postscutellar elytral puncture row. *Aproida* has this short puncture row, though it is sometimes practically obliterated by irregular adjacent punctures and swollen interspaces. Würmli (1975) mentioned that the affinities of *Aproida* were unclear, and added that its looks were most similar to the Australian *Eurispa*. The Eurispini is mainly Australian-based, with the bulk of the species in *Eurispa* from Australia and New Guinea. Each of the remaining two eurispine genera contains one species, with *Leucispa* in Australia and *Squamispa* in India. The conformation of the head in *Aproida* and *Eurispa* indicates some distance between the two tribes. In the former the front of the head is vertical and the antennal bases are prominent and close to the mouth, but in the latter the front is deflected and the antennal bases are distant from the mouth. Each group has its characteristic facies, even though both (excluding the Indian *Squamispa*) have each elytron with an acute apex - the aproidines are much stouter with some compression to the body and the eurispines are



FIGS 1-3. *Aproidea*, dorsal view: 1, *A. balyi*, ♂ (body length 11.55 mm); 2, *A. cribrata*, holotype (body length 5.95 mm); 3, *A. monteithi*, sp. nov., holotype ♀ (body length 8.95 mm).

quite narrow and parallel-sided, and more cylindrical in the body. Würmli's (1975) remark that *Aproida* is one of the most remarkable of all Hispinae is easy to accept, especially when considering the life-history of one of its members. The obvious great phylogenetic distance between *Aproida* and its closest (yet unknown) relative and its geographical restriction suggest a long period of isolation and Gondwanan origins.

KEY TO SPECIES OF APROIDA

1. Elytron flattened for most of length, lacking discal prominences; pronotal disc concave, lacking longitudinal carinae; antenna with 2 apical segments pale 2
Elytron not flattened, disc with irregular elevations; pronotal disc with a pair of submedian longitudinal carinae plus weak sinuate longitudinal elevations sublaterally; antenna with only apical segment pale; body length 5.95 mm *cribrata* Lea
2. Antenna with segments 3-5 elongate, with apices not swollen; dorsum largely pale with dark stripe along side; elytral disc lacking dark oblique markings; body length 9.4-12.45 mm *balyi* Pascoe
Antenna with segments 3-5 elongate, with apices distinctly swollen; dorsum largely pale but pronotum with dark lateral stripe and elytral disc with dark oblique line on basal half and a fainter one behind middle; body length 8.95-9.15 mm *monteithi* sp. nov.

Aproida balyi Pascoe, 1863
(Fig. 1)

MATERIAL EXAMINED

QUEENSLAND: Brisbane, 7.11.16, H. Hacker, QMBA coll. (1♂); same loc., A.P. Dodd, QMBA coll. (1♀); same loc., 8-16.10.61, C.F. Ashby, ANIC coll. (1♀); same loc., 7.Dec.1972, P. Turner, ANIC coll. (1♀); Brookfield, 25.ix.72, J. Sedlacek, JS coll. (1♀); same data, but 25.x.72 (1♀); same data, but 25.x.73 (1♂); Brookfield, Gold Crk, 4.ix.1983, ex *Eustrephus* leaves, J. Conran, QMBA coll. (1♂ in cop.); Bunya Mt N.P., 5.May.1978, B.J. Selman, ANIC coll. (1♂); Cairns, SAMA coll. (1♂, 1♀); same loc., A.M. Lea, SAMA coll. (1♀); same loc., 3/50, G. Brookes, ANIC coll. (1 minor♂); same loc., 7.1.1952, J. Sedlacek, BPBM coll. (1♀); Cedar Crk, 28.9.30, H. Hacker, QMBA coll. (1♀); Cunningham's Gap, 20.xi.60, J.L. Gressitt, BPBM coll. (1 minor♂); Eungella, 700 m, 28.1.82, J. Sedlacek, BPBM coll. (2♂♂, 1 minor♂, 4♀♀); Kuranda, G.E. Bryant, F.P. Dodd 194, ANIC coll. (1♂, comp. with type by E.B. Britton);

[Lamington] National Park, Dec.1919, H. Hacker, QMBA coll. (1♂); same loc., 20.III.62, G.B. Monteith, BPBM coll. (1♀); Maleny, 12.1.27, H. Hacker, QMBA coll. (1♂); Moreton Bay, AMSA coll. (1♂, 1♀ without printed label); Mt Macalister, Cardwell Range, 900 m, 18.18S 145 56E, 18-20.Dec.1986, Monteith, Thompson & Hamlet, QMBA coll. (1♂); Mt Mee, 10.9.28, H. Hacker, QMBA coll. (2♂♂, 1♀); Mt Tambourine, A.M. Lea, SAMA coll. (1♂); same loc., A.M. Lea, AMSA coll. (1♀, det. A.M. Lea); Nanango Dist., 26.3.28, H. Hacker, QMBA coll. (1♀); Pine Mountain, ANIC coll. (2♀♀, one without loc. label, permanent loan from Macleay Mus.); nr Rockhampton, J. Sedlacek, BPBM coll. (2♀♀); Springbrook Plateau, 24.xi.1982, on *Eustrephus* leaves, J. Conran, QMBA coll. (2 minor♂♂); same data, but feeding and laying on *Eustrephus* leaves (1♀); S Johnstone R., H.W. Brown, SAMA coll. (1♂, 1♀); Stanthorpe, 1955, J. Sedlacek, BPBM coll. (1♂); Toowoomba, Koebele Coll., BPBM coll. (1♂, 1♀ without locality label); same loc., Nov.1980, J. Macqueen, ANIC coll. (2♂♂, 1 minor♂, 2♀♀); Ugly Gully, S.E.Q., 1.v.1969, E.C. Dahms, QMBA coll. (1♂); Woomby nr Nambour, 16.x.65, D.H. Colless, ANIC coll. (1♀); Wyreema, O.W. Tiegs, AMSA coll. (1♀, det. A.M. Lea); Queensland, without locality, SAMA coll. (1♀); NEW SOUTH WALES: trib. of Busby's Creek, SE of Tabulam, 29 02S 152 43E, 29.8.82, O. Griffiths, AMSA coll. (1♀); Bundjalung N. P. nr Iluka, 12 March 1981, M.J. Fletcher & G.R. Brown, NSW coll. (1♂, det. T.G. Vazirani); same data, but at Iluka Turnoff (1♂); Dingo Tops Forest Park, NW of Wingham, 8.Jan.1984, rainforest margin, G. Williams, ANIC coll. (1♀); Dorrigo, W. Heron, SAMA coll. (1♀); same loc., ANIC coll. (1♂, det. H.J. Carter); Gibraltar Range N.P., NSW, 15-17.Nov.1979, N.W. Rodd, AMSA coll. (1♀); Glen Innes, Prison Farm, July 1969-Dec.1970, ANIC coll. (1♂, 2♀♀); Hastings R., NSW, 1934, H.J. Davidson, AMSA coll. (1♀); Lansdowne S.F., 31 45S 152 32E, 19.Feb.1983, T. Weir & A. Calder, ANIC coll. (1♂); Maclean locality, lower Clarence R., 9.Nov.1940, A.A. Cameron, AMSA coll. (1♂); Mt Glennie, 16 km E of Woodenbong, 400 m, 24.Nov.1982, G.B. Monteith & D. Yeates, QMBA coll. (3♂♂, 1 minor♂, 1♀); same data, BPBM coll. (2♀♀); Ourimbah, xii.05, Helms Coll., BPBM coll. (1♀, det. J.L. Gressitt); Rivertree, 10.10.31, E. Sutton, QMBA coll. (1♂, 1♀, and 1♂ without date); Ulong, East Dorrigo, W. Heron, AMSA coll. (1♂, 1♀).

REDESCRIPTION

Dorsum largely pale, yellow- or orange-testaceous, with dark fuscous narrow stripe extending posteriorly from behind eye, thence along side of prothorax and continuing along elytron from humerus to extreme apex; antenna with segments 1-9 black, 10-11 pale testaceous; ventral surfaces and legs yellow- to orange-testaceous.

Head rather deeply emarginate anteriorly between enlarged antennal bases; front smooth and concave between antennal bases; vertex broadly and shallowly concave anteriorly and

bearing large shallow punctures; occiput with a series of fine transverse sulci behind posterior margin of eye. *Antenna* extending to about basal fifth of elytron; segments 1-4 smooth and bearing sparse punctures; 5-11 dull, densely micropunctate and clothed with fine pubescence. *Prothorax* strongly narrowed anteriorly; anterior angle toothed at side of anterior margin; lateral margin absent; posterior angle just acute; base convex medially, concave laterally and partly concealed by elytral bases; disc broadly concave and bearing large shallow punctures. *Scutellum* small, apex subtruncate-rounded. *Elytron* broadest at humerus and narrowed posteriorly to acute slightly upturned apical spine; apex also with small tooth at sutural extremity; discal punctures large, confused to irregular, with interspaces tending to be swollen longitudinally. *Ventral surfaces* smooth; metasternum not conspicuously punctate along anterior and lateral margins; abdominal segments 1-2 connate. *Legs*: proleg strongly modified in ♂ and hardly so in ♀; ♂ profemur strongly swollen with preapical concavity; ♂ protibia strongly arched basally and bearing 1 or 2 large isolated teeth preapically; probasitarsus more turgid in ♂ than in ♀; ♀ profemur not strongly swollen, slightly constricted preapically; ♀ protibia not arched basally and lacking prominent preapical teeth.

Measurements: ♂ (Kuranda; comp. with type [ANIC]). Body length 10.5 mm; breadth 3.3 mm; head breadth 1.47 mm; eye 0.78 x 0.56 mm; gena 0.19 mm; interantennal space (above) 0.38 mm; antennal socket breadth 0.26 mm; antennal segment lengths (1/100s mm): 44 : 36 : 72 : 56 : 52 : 48 : 48 : 40 : 40 : 38 : 58; head + pronotal length 3.3 mm; pronotal length (mid) 1.68 mm; pronotal breadth (apex) 1.50 mm; pronotal breadth (base) 2.42 mm; elytral length 7.47 mm.

Female (Mt Glennie [QMBA]). Body length 11.55 mm; breadth 3.9 mm; head breadth 1.56 mm; eye 0.80 x 0.60 mm; interocular space (above) 0.98 mm; gena 0.19 mm; interantennal space 0.38 mm; antennal socket breadth 0.28 mm; antennal segment lengths (1/100s mm): 44 : 34 : 70 : 52 : 48 : 42 : 40 : 40 : 40 : 40 : 62; head + pronotal length 3.65 mm; pronotal length (mid) 1.88 mm; pronotal breadth (apex) 1.74 mm; pronotal breadth (base) 2.68 mm; elytral length 8.22 mm.

Sex ratio and variation ($n = 83$): ♂♂ : ♀♀ = 45 : 38. Of the 45 ♂♂, 7 'minor ♂♂' had the profemur and protibia less strongly developed, the latter bearing 1 instead of 2 teeth, with the upper tooth being absent or nearly so. Würmli (1975) included diagrams of the body and profemur + tibia of a

'normal' ♂. Dorsal coloration is basically pale green in life (Monteith, 1970) fading to pale yellow- to darker orange-testaceous in dried specimens; the dark line along side faint or suffused along head and pronotum but sometimes quite distinct along pronotum, and usually complete and distinct on elytron, though sometimes faint or absent along middle of elytron or along entire basal half; apical elytral spine dark in all specimens examined. Antennal segments 1-9 usually dark fuscous to black, occasionally paler reddish or pitchy fuscous, rarely with 9 becoming pale; 10-11 pale yellow-testaceous in all examples seen.

REMARKS

This is by far the most common of the three species, and can be found on its host plant, *Eustrephus latifolius* Benth. & Hook., in and east of the Dividing Range in northern New South Wales and Queensland. Monteith (1970) described the life history of this insect, whose habits are very peculiar among the Hispinae. He noted that all the life stages are passed completely exposed on the host plant, including the pupa. The pupa, which is suspended from the withered skin of the final larval instar, closely resembles the pendant flower buds of the host plant (figured in Monteith, 1970).

Aproidea cribrata Lea, 1929

(Fig. 2)

MATERIAL EXAMINED

QUEENSLAND: [Lamington] National Park, xii.1921, H. Hacker, QMBA coll. (Holotype)

REDESCRIPTION

HOLOTYPE: Body surfaces pitchy orange to red-testaceous, with dark fuscous markings having a metallic violaceous lustre; antenna with segments 1-7 reddish, 8-10 piceous, and 11 pale yellow-testaceous; ventral surfaces orange-testaceous to pitchy fuscous, generally darker on parts of thorax and paler on abdomen; legs orange-testaceous.

Head briefly truncate anteriorly between antennal bases and with outline of median frontal carina visible from above; antennal bases not swollen; front flattened, median carina prominent; vertex broadly depressed centrally and strongly punctate, sulcate anteriorly; surface of side behind eye rugose-punctate and lower side of head behind eye and gena punctate. *Antenna* extending to about basal fifth of elytron; segments 1-6 smooth, even though densely punctate; 7-11 dull, more closely pubescent and not so distinctly punctate.

Prothorax only slightly narrowed anteriorly; anterior angle toothed at side of anterior margin; lateral margin absent; disc with a pair of submedian longitudinal carinae (1 + 1) plus weak sinuate longitudinal elevations sublaterally; surface otherwise strongly punctate. *Scutellum* small, apex rounded. *Elytron* moderately convex along side, narrowing preapically to apical spine; disc costate-punctate; punctures large, deep and more or less placed in regular rows; 4 coarse costae apparent, these thickened and narrowed at intervals. *Ventral surfaces*: prosternum coarsely punctate; mesosternum with larger close punctures (3 or 4 occupying visible area); metasternum short, surface alutaceous, sparsely micropunctate but with heavy impressed punctate margins anteriorly and laterally; abdominal sternites 1-2 connate. *Legs*: femora moderately heavy, slightly constricted preapically; tibiae slender.

Measurements: body length 5.95 mm; breadth 2.45 mm; head breadth 1.05 mm; eye 0.52 x 0.38 mm; interocular space (above) 0.58 mm; gena 0.23 mm; interantennal space 0.18 mm; antennal socket breadth 0.18 mm; antennal segment lengths (1/100s mm): 31 : 20 : 46 : 30 : 25 : 18 : 20 : 18 : 18 : 16 : 29; head + pronotal length 2.00 mm; pronotal length (mid) 1.08 mm; pronotal breadth (apex) 1.26 mm; pronotal breadth (base) 1.44 mm; elytral length 4.00 mm.

REMARKS

The holotype appears to be the only known representative of this species, despite its being from a heavily collected locality (G. B. Monteith, pers. comm.). This specimen is brachypterous and the species is probably not capable of flight. The metasternum is extremely short at about 8% of entire body length (metasternum measures 0.5 mm in length) and the surface is weakly turgid, while the two congeners have the metasternum of normal large size at about 15% as long as entire body length and with its surface turgid. Also, the whole length of the wing extends without folds to about the end of the abdomen, indicating some reduction.

Aprodisa monteithi sp. nov.

(Fig. 3)

MATERIAL EXAMINED

QUEENSLAND: Thornton Peak summit, via Daintree, 20.ix.1981, 1372 m (4500') elevation, G.B. Monteith (Holotype ♂, allotype ♀).

Type deposition: Holotype and allotype in QMBA.

DESCRIPTION

HOLOTYPE: Male. Body surfaces yellow-testaceous, with dark fuscous metallic markings as follows: a postoccipital stripe along side of head, a narrow median and a broader lateral stripe on pronotum, a short postscutellar mark on elytral base, a line extending from a short distance behind humerus obliquely and nearly to suture at middle of elytron, another oblique line preapically, and almost entire apical spine; antenna with segments 1-9 dark fuscous, some having paler bases, 10-11 pale testaceous; ventral surfaces largely yellow-testaceous; prosternum with postcoxal dark area extending to posterior angle; mesepisternum and mesepimeron marked with fuscous; metasternum with fine dark border anteriorly and laterally; legs yellow-testaceous stained with fuscous, tibiae slightly darker than femora; tarsi fuscous.

Head gently concave anteriorly between swollen antennal bases; front triangular and flattened with fine median sulcus; vertex rather deeply concave anteriorly around short median longitudinal impression and bearing a few large punctures; postocciput with series of subtransverse sulci behind posterior margin of eye. *Antenna* extending to about basal fifth of elytron; segments 1-5 relatively smooth and moderately punctate; 3-5 distinctly swollen at apices; 6-11 dull and finely pubescent. *Prothorax* strongly narrowed anteriorly; anterior margin concave; anterior angle toothed on margin at side; side briefly swollen at middle, lacking distinct lateral margin; posterior angle briefly rounded; base convex medially, concave laterally where it can be covered by elytral base; disc somewhat irregular, concave prebasally, with fine median line; discal punctures deep, moderately distributed, but fewer submedially, larger and closer laterally where interspaces are mostly raised. *Scutellum* small, quite rounded apically. *Elytron* broadest along middle, thence narrowed preapically to large slightly upturned apical spine; apex also with a small tooth at sutural extremity; humerus prominent; discal punctures deep in irregular rows; mesal punctures largest and grouped most closely; lateral punctures with interstices more strongly swollen and irregular but some interstices tending to form weak costae. *Ventral surfaces* largely smooth; prosternum sparsely punctate; mesosternum more closely punctate; mesepisternum and mesepimeron with large punctures; metasternum smooth with fine impressed closely punctate margins anteriorly and laterally; abdominal sternites 1-2 connate. *Legs* slender.

Measurements: Body length 8.95 mm; breadth

3.0 mm; head breadth 1.42 mm; eye 0.66 x 0.48 mm; interocular space (above) 0.76 mm; gena 0.28 mm; interantennal space 0.34 mm; antennal socket breadth 0.23 mm; antennal segment lengths (1/100s mm): 36 : 32 : 58 : 48 : 48 : 36 : 30 : 26 : 28 : 28 : 44; head + pronotal length 2.74 mm; pronotal length (mid) 1.38 mm; pronotal breadth (apex) 1.50 mm; pronotal breadth (base) 2.10 mm; elytral length 6.39 mm.

ALLOTYPE: Female. Nearly identical to holotype. Antennal segments 1-5 pitchy fuscous instead of black, 5-9 dull fuscous instead of black.

Measurements: Body length 9.15 mm; breadth 3.40 mm; head breadth 1.44 mm; eye 0.62 x 0.44 mm; interocular space (above) 0.76 mm; gena 0.28 mm; interantennal space 0.34 mm; antennal socket breadth 0.22 mm; antennal segment lengths (1/100s mm): 36 : 32 : 56 : 48 : 48 : 40 : 30 : 26 : 26 : 28 : 44; head + pronotal length 2.65 mm; pronotal length (mid) 1.38 mm; pronotal breadth (apex) 1.56 mm; pronotal breadth (base) 2.06 mm; elytral length 6.64 mm.

REMARKS

The general facies and size of the new species show a greater resemblance to *Aproidea balyi* than to *A. cribrata*. See key for differences.

The new species is dedicated to Geoff B. Monteith of QMBA, collector of the specimens. Dr Monteith said that the specimens were knocked down after applying a pyrethrum spray in low dense moss forest at the summit of Thornton Peak. He mentioned that he had searched for possible plant hosts without finding any. The exact site was again visited in September 1984 and the

same collecting techniques were applied, but no *Aproidea* were found (pers. comm.).

ACKNOWLEDGMENTS

I am indebted to Geoff B. Monteith (QMBA) for providing the material that made this study worth pursuing, and also to G. R. Brown (NSWA), G. A. Holloway (AMSA), John F. Lawrence (ANIC), E. G. Matthews (SAMA), and Josef Sedlacek (JS) for lending specimens of *Aproidea balyi*. Michelle Chun (BPBM) prepared the illustrations. I am grateful to Felicia Bock, E. Gorton Linsley, and daughters of the late J. L. Gressitt for partial support to the J. Linsley Gressitt Center for Research in Entomology at Bishop Museum.

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AUSTRALASIAN ANTS OF THE GENUS *LEPTOTHORAX* MAYR (HYMENOPTERA :
FORMICIDAE : MYRMICINAE)

ROBERT W. TAYLOR

Taylor, R.W. 1989 11 13: Australasian ants of the genus *Leptothorax* Mayr (Hymenoptera : Formicidae : Myrmicinae). *Mem. Qd Mus.* 27(2): 605-610, Brisbane. ISSN 0079-8835.

The following species are discussed: *L. bilongrudi* sp. nov. (Papua New Guinea), *L. australis* Wheeler, and *L. renateae* sp. nov. (both North Queensland). The Australian species have peculiar lateral subocular carinae. *Leptothorax*, as presently constituted, is otherwise unknown from the Indo-Australian area.

□Ants, Formicidae, taxonomy, *Leptothorax*, Myrmicinae.

Robert W. Taylor, Australian National Insect Collection, CSIRO Division of Entomology, GPO Box 1700, Canberra, Australian Capital Territory 2601, Australia; 30 November, 1988.

Leptothorax is a large and important myrmicine ant genus with over 200 nominal species known from the Palearctic, Ethiopian, Nearctic and Neotropical regions. Its diagnosis, synonymy and distribution were reviewed, with a monograph of the 11 Afrotropical species, by Bolton (1982). Apart from the three species considered here the genus has not been reported from the Indo-Australian area south of the Tropic of Cancer and east of Bangladesh (if one excludes the possibility, now under investigation by the author, that the Australian regional generic names *Podomyrma* Fr. Smith, *Dacryon* Forel, and *Pseudopodomyrma* Crawley, which were synonymised under *Podomyrma* by Taylor and D.R. Brown (1985), should all properly be considered junior synonyms of *Leptothorax*). The Sumatran generic record mentioned in passing by Wheeler (1934), when he described *L. australis* from north Queensland, seems never to have been substantiated. *L. bilongrudi* sp. nov. is the first species to be described from New Guinea, and *L. renateae* sp. nov. the second from Australia. These ants are poorly represented in collections, perhaps because they nest and forage arboreally and would thus tend to be overlooked by most ant collectors. In any case they appear to be rare. The three are apparently closely related; all have a typical *Leptothorax* palpal formula (maxillary 5:labial 3; confirmed in each by dissection), with 12-segmented antennae, unusual mandibular dentition, (described below under *L. bilongrudi*), and angularly projecting dorsolateral mesonotal borders. Twelve-segmented antennae are more usual than the alternative 11 in *Leptothorax*, and mesonotal projections are found in some neotropical species (Kempf, 1958, 1959). The mandibular dentition, however, apparently sets these species apart from all other members of the genus. In addition, the Australian species both have an unusual subocular

carinal complex on either side of the head. Each of these consists of a pair of equally very fine, closely parallel carinae, separated by a minute groove, which is about equal in width to an individual carina. These run together from the mandibular bases to meet the occipital carina on each side at an oblique angle (Fig. 4). Such structures have not been reported from other *Leptothorax* species. Somewhat similar carinae are seen in some species of *Myrmecina* Curtis, but otherwise they appear uniquely to characterise *L. australis* and *L. renateae*. Some records are cited using 1 degree coordinates to indicate mapping grid cells, as in Taylor (1987).

Specimens studied here are from the Australian National Insect Collection (ANIC) and the Queensland Museum (QM). Abbreviations for other collections are: BISHOP — B.P. Bishop Museum, Honolulu, Hawaii, USA; BM(NH) — British Museum (Natural History), London; GM — Museum d'Histoire Naturelle, Geneva, Switzerland; KUB — Masao Kubota collection, Odawara City, Japan; MCZ — Museum of Comparative Zoology, Cambridge, Massachusetts, USA. Conventions for measurements and indices follow Bolton (1982); HL is maximum head length, and HW the maximum width of the head behind the eyes.

Leptothorax bilongrudi sp. nov.
(Figs 1-3)

TYPE LOCALITY

PAPUA NEW GUINEA: West Sepik Province, Victor Emanuel Range, at 5°07'S, 141°38'E, near Telefomin.

MATERIAL EXAMINED AND DISTRIBUTION

Known only from the type locality: holotype worker, 11 paratype workers, 2 paratype dealate females, taken at 1550 m (R.J. Kohout acc. 1984.305, 17-19 Aug.).

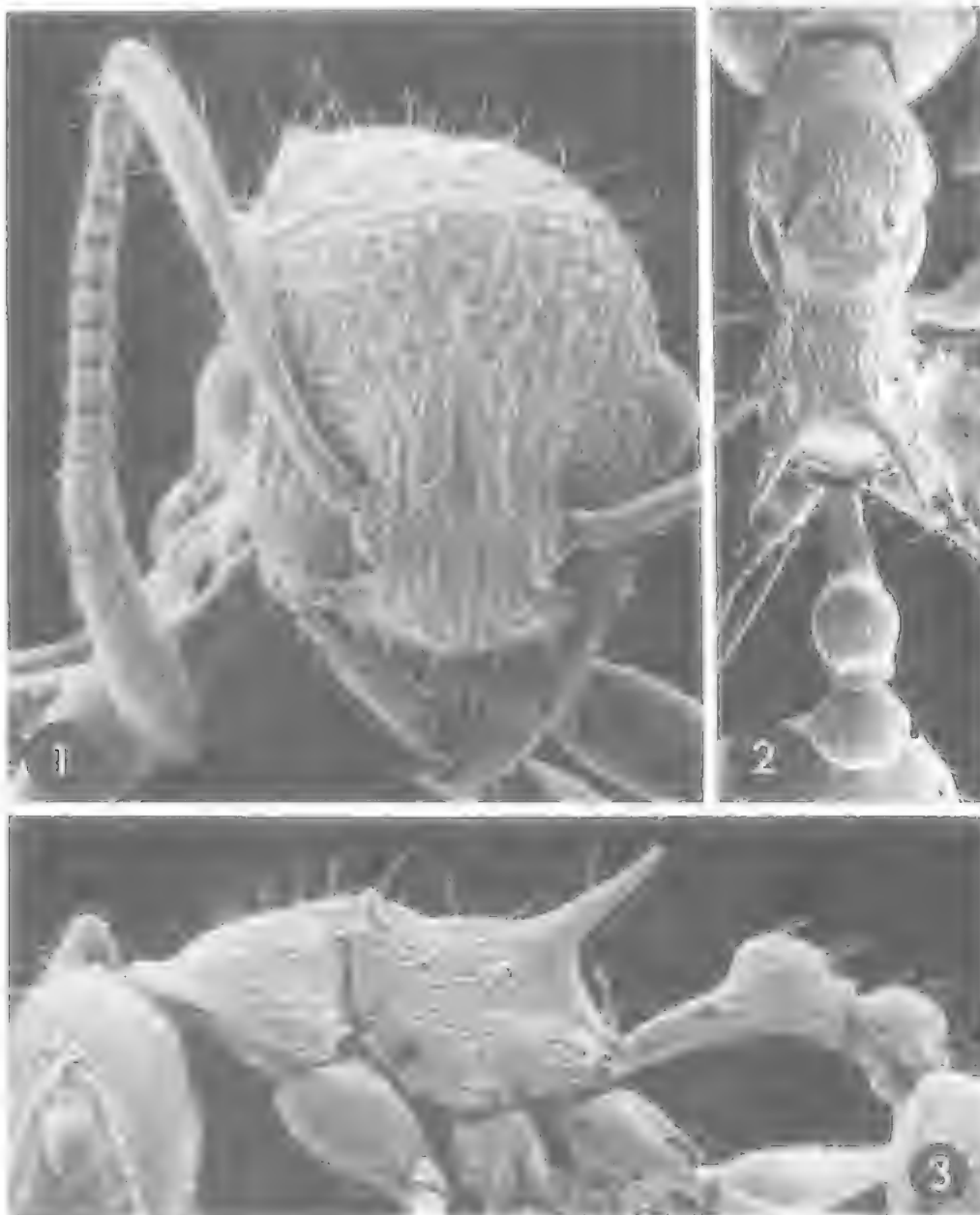
Holotype gold-coated for scanning electron microscopy, mounted with a colour-matched paratype. Holotype, most paratypes, including females, in ANIC (type No. 7774), worker paratypes in BISHOP, BM(NH), GM, KUB, MCZ, QM.

ETYMOLOGY

Named for the collector, Rudolf Kohout. The specific epithet is undeclinable Papua New Guinea pidgin, meaning 'belonging to Rudi'.

WORKER

Dimensions (mm, holotype, smallest paratype, largest paratype (ranked by HW)): TL c. 4.5–6.2; HL 1.14, 0.98, 1.24; HW 0.96, 0.84, 1.24; CI 84, 86, 89; SL 1.16, 0.97, 1.27; SI 102, 99, 102; PW 0.75, 0.63, 0.83; AL 1.56, 1.34, 1.77. General features as in Figs 1–3. Mandibular dentition unusual for *Leptothorax*; consisting of 3 apical and 2 basal teeth separated by a long, minutely



FIGS 1–3. *Leptothorax bilongrudi*, holotype worker, standard views. HW 0.96 mm; PW 0.75 mm; AL 1.56 mm.

crenulate, edentate blade; third apical tooth separated from second by a brief diastema; basal tooth formed from the slightly raised obtuse angle separating the inner and posterior mandibular borders. Median anterior clypeal border minutely emarginate; median clypeal carina barely differentiated from surrounding sculptural elements; frontal area a shallow depression. Eyes almost hemispherical, their longest diameters spanning 12–15 facets. Frontal carinae and lateral suborbital carinae lacking. Occipital border evenly arched in frontal view. A distinct occipital carina closely encloses the nape, and extends anteromedially on each side below the head to terminate on the postgena at about the level of the posterior border of the adjacent eye, short of the genal suture. Antennae 12-segmented, club 3-segmented, differentiated by the relative length of its segments, rather than by a marked step in their thickness; scapes when extended exceeding occipital border by around 1/3 their length. In dorsal view, pronotal collar relatively broad; humeri evenly rounded. Mesonotum narrow, separated from pronotum by a shallow, depressed sutural remnant; dorsolateral borders extended as acute salient projections terminating a slightly raised obtuse transverse crest. Propodeal spines long, posterodorsolaterally divergent, almost straight, with apices minutely upturned. Metapleural lobes somewhat salient, narrowly rounded. Petiolar peduncle proportionately very long and distinctly set-off from the node; spiracular rims slightly raised in dorsal view; subpetiolar process a minute anteroventral angle; node rounded in all directions, almost hemispherical, slightly longer than wide in dorsal view. Postpetiole as illustrated, almost circular in dorsal view, minutely wider than long. Sting somewhat transversely flattened and blade-like.

Mandibles smooth, except for piligerous punctures and faint, effaced traces of longitudinal sculpturing on their bases and outer borders. Clypeus with spaced longitudinal rugae. Frons rugoreticulate, more so posteriorly; interstitial microsculpture obscure, except on each side between the antennal insertion and eye; sculptural intensity diminishing progressively below the eyes; postgenae essentially smooth. Mesosoma less intensively sculptured than head; sculpture of petiole and postpetiole even more reduced; gaster smooth and shining, with a few very short basal ribs surrounding its articular condyle. Pilosity as illustrated; the hairs tapered and apically pointed; those on gastral dorsum scattered, separated by almost their average length. Colour medium-dark

brown with a reddish-orange cast under magnification, scapes and legs a little lighter, antennal funiculi medium-brown.

FEMALE

The largest female paratype has HW 1.17, and the smallest: HL 1.27; HW 1.10; CI 87; SL 1.15; SI 105; scutum W 0.92; AL 1.90. Differing from the worker in the usual features. Ocelli small, surrounding a slightly raised triangle into which each is somewhat inserted and directed more-or-less outwards. Scapes relatively short, exceeding occipital border by about 1/4 their length when extended. Scutum lacking notaulices or parapsidal lines. Anterolateral corners of scutellum extended laterally as rounded, minutely bowl-shaped lobes (possible homologues of the worker mesonotal extensions). Petiolar peduncle shorter and more tapered than in worker. Postpetiole distinctly broader than long in dorsal view. Propodeal spines relatively short, less divergent than in worker; about as long as the petiolar peduncle, as also in the worker.

Sculpturing much as in worker; the frons more closely reticulate, with more distinct interstitial microsculpture; postgenae with quite strong, somewhat effaced sculpture. Mesosomal sculpturing relatively strong, more as on the frons. Pilosity and colour as in worker.

Leptothorax australis Wheeler

Leptothorax australis Wheeler, 1934: 60, worker. Type locality: Queensland, Cairns District. (*L. (Goniorthorax) australis*). Holotype in MCZ (examined).

MATERIAL EXAMINED AND DISTRIBUTION

Known only from north Queensland (grid cells 16/145 and 17/145; provisionally also 11/142 (female record)). Modern records are: Bellenden Ker Range, cableway base station, worker, 100 m (Earthwatch/Queensland Museum, 25–31 Oct, 1981, QM); Palmerston N.P., 9 workers on branch of recently felled giant rainforest tree (B.B. Lowery, 5.8.1975, ANIC, BM(NH), GM, MCZ); 8 km W of Tully, near Rocky Ck Bridge, 3 workers, in dead vine, lowland rainforest (B.B. Lowery, 22.9.1980, ANIC, QM). An alate female provisionally identified as *L. australis* (see below) was collected much further north: 15 km W of Capt. Billy Creek, Great Dividing Range (11°40'S, 142°45'E), (G.B. Monteith, 4–9.vii.1975).

WORKER

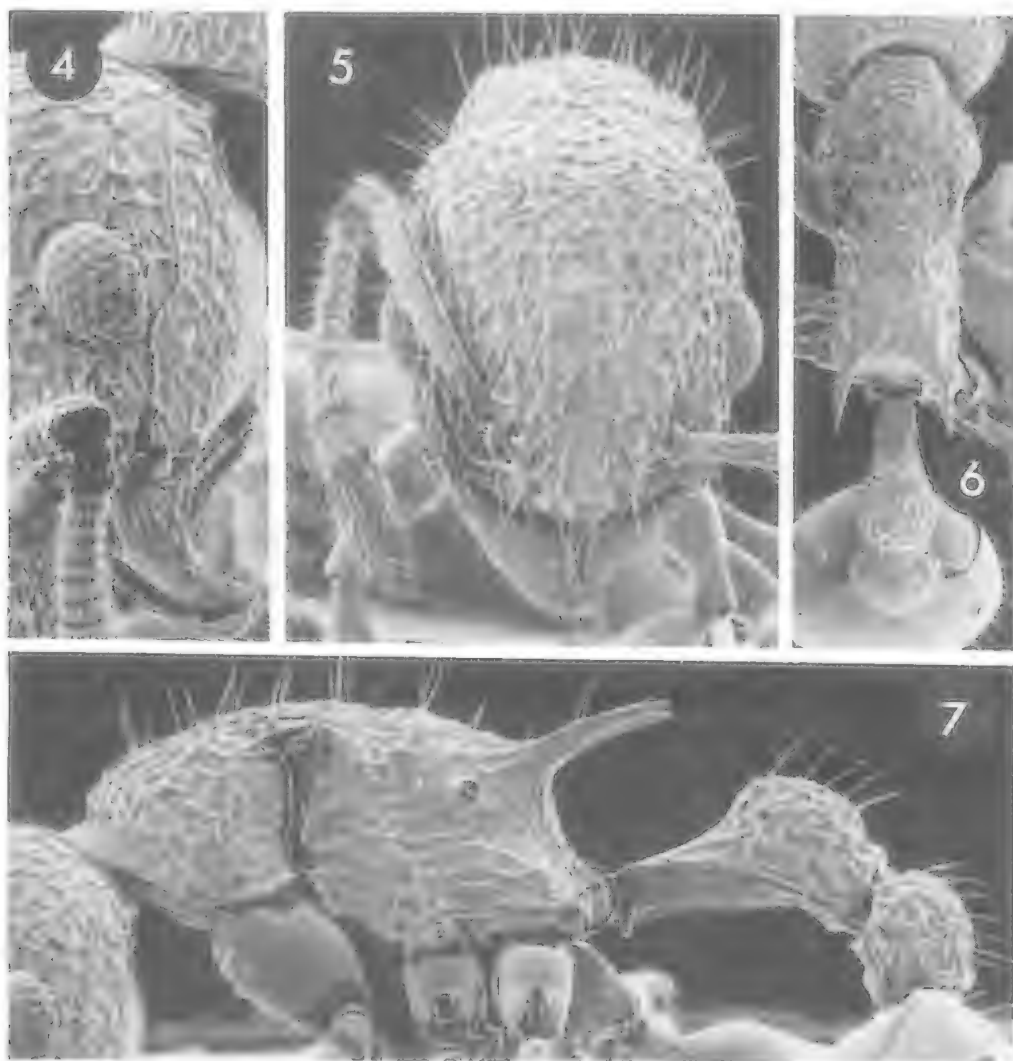
The smallest and largest available specimens (both from Palmerston N.P.) have the following dimensions (mm): TL c. 2.3, 2.6; HL 0.74, 0.78;

HW 0.63, 0.68; CI 85, 87; SL 0.49, 0.53; SI 78, 78; PW 0.46, 0.50; AL 0.90, 1.00. General features as in the original description, which omitted reference to the suborbital carinae (which are obscured on the holotype by mounting glue). They are almost exactly as illustrated for *L. renateae* (Fig. 4), except that each is more nearly straight below the eye. The sculpturing below the carinae is more finely textured and less reticulate than that above, unlike *L. renateae*, where both areas are similarly configured. The suborbital carinae are not homologous with the postgenal extensions of the occipital carina described for *L. bilongrudi*, since the latter are also present in *L. australis*.

Mandibular dentition as described above for *L. bilongrudi*; the third apical tooth disproportionately small; the two posterior teeth vestigial.

FEMALE

The female listed above is only slightly larger than the workers (HL 0.75, AL 1.21), and agrees with their salient features, including details of hair structure, propodeal spine length, and configuration of the sculpturing above and below the suborbital carinae. The petiolar node is slightly longer than wide in dorsal view, proportioned much as in *L. renateae* workers, but with the anterodorsal border less convex. There are no traces of frontal carinae.



FIGS 4–7. *Leptothorax renateae*, holotype worker: 4, lateral view of head, showing suborbital carina; 5–7, standard views. HW 0.71 mm; PW 0.49; AL 1.10 mm.

Leptothorax renateae sp. nov.

(Figs 4-7)

TYPE LOCALITY

QUEENSLAND: 11 km ENE of Mt Tozer (12°43'S, 143°18'E).

MATERIAL EXAMINED AND DISTRIBUTION

Known only from north Queensland (grid cells 12/143, 16/145): Mt Tozer area (distances and bearings from Mt Tozer): type locality, holotype worker, paratype worker (T. Weir, 11-16 July 1986, rainforest litter, ANIC berlesate 1064); same data but 3 km ENE, 12°44'S, 143°14'E, paratype worker (1-4 July 1986, ANIC berlesate 1052). Iron Range, E Claudie River, 20 m, dealate female (G. Monteith, 6 Dec. 1985, rainforest, stick brushing, QM berlesate 694). Cape Tribulation area (distances and bearings from the Cape, all coll. Monteith, Yeates and Thompson, 1982, rainforest pyrethrum knockdown samples): 2.0 km WNW (site 2), 7 Oct., 50 m, 2 paratype workers; 3.5 km W (site 7), 2 Oct., 680 m, dealate female; 4.5 km W (site 9), 2 Sep., 760 m, dealate female. Cape Tribulation area, 16°03' to 16°05'S, 145°28'E, littoral rainforest, paratype worker (A. Calder and T. Weir, 21-28 Mar. 1984, ANIC berlesate 940). Mossman Gorge, 3 mi E of Mossman, rainforest, paratype worker, c. 200 ft (R.W. Taylor acc.1966.90, 27-29 X.). All worker specimens except holotype designated paratypes; the females are only provisionally identified, and are not designated as paratypes. Holotype, most paratypes, and females, in ANIC (type No. 7773), worker paratypes in BM(NH), QM. Holotype gold-coated for scanning electron microscopy, mounted with a colour-matched paratype.

ETYMOLOGY

Named with gratitude for my assistant Renate Sadler.

WORKER

Dimensions (mm) of the smallest paratype (Cape Tribulation) and the holotype (the largest type) are: TL c. 3.4, 3.6; HL 0.74, 0.77; HW 0.63, 0.71; CI 86, 92; SL 0.57, 0.57; SI 90, 80; PW 0.49, 0.52; AL 0.97, 1.10. General features as in Figs 4-7. Very similar to *L. australis*, and agreeing in general with its original description, with the following differences: (1) Faint vestiges of frontal carinae present on head, extending back from posterior extremities of frontal lobes to slightly beyond level of posterior margins of eyes; each carina is essentially a minutely raised element of the longitudinal sculpturing, and is usually better developed posteriorly than in its medial section. There are no traces of such structures in *L. australis*, and they are more distinct in southern than northern specimens of *L. renateae*. (2) Pronotal humeri evenly rounded in dorsal view,

versus epaulate in *L. australis*. (3) Propodeal spines 1.3-1.5 times longer than the distance separating their bases, *versus* about as long as that distance in *L. australis*. (4) Petiolar node in dorsal view distinctly longer than wide, *versus* slightly wider than long in *L. australis*. (5) Lateral mesonotal projections larger and more prominent. (6) Pilosity consisting of moderately long tapered hairs with narrowly acute apices, relatively about 1.5-2 times as long as those of *L. australis*, which has untapered, blunt, minutely clubbed hairs. Mandibular dentition and suborbital carinae much as in *L. australis*. Southern specimens tend to be smaller, with proportionately narrow heads and long scapes.

FEMALE

The females listed above are only slightly larger than the workers, and agree with them in the same features noted above for *L. australis*. Frontal carinae as in worker; petiolar node in dorsal view relatively slightly longer proportional to its width. The mesosoma relatively bulky in the Iron Range specimen.

KEY TO AUSTRALASIAN LEPTOTHORAX SPECIES (WORKERS AND FEMALES)

1. Subocular carinae present on each side of head, extending from mandibular base to occipital carina (Fig. 4); scapes short, failing to reach occipital border when laid back (Fig. 5); Australian species 2
Subocular carinae lacking (Fig. 3); scapes relatively long, clearly exceeding occipital border when laid back (Fig. 1); New Guinean species *L. bilongrudi* sp. nov.
2. Pilosity consisting of moderately long, tapered hairs with finely acute apices (Fig. 7); petiolar node distinctly longer than broad in dorsal view *L. renateae* sp. nov.
Pilosity consisting of short, blunt or minutely clubbed hairs, proportionately about 1/2 to 2/3 as long as those in Fig. 7; petiolar node in dorsal view as broad or slightly broader than long *L. australis* Wheeler

ACKNOWLEDGEMENTS

The cooperation of Rev. B.B. Lowery SJ, Rudolf Kohout, Dr G.B. Monteith and Barry Bolton is gratefully acknowledged. Colin Beaton assisted with the preparation of the figures.

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TEMPORAL AND SPATIAL ZONATION OF THE DEMERSAL TRAWL FAUNA OF THE CENTRAL GREAT BARRIER REEF

R.A. WATSON AND G. GOEDEN

Watson, R.A. and Goeden, G. 1989 11 13: Temporal and spatial zonation of the demersal trawl fauna of the central Great Barrier reef. *Mem. Qd Mus.* 27(2): 611-620. Brisbane. ISSN 0079-8835.

Management needs for zonation of the central Great Barrier Reef Marine Park by user activity prompted a study of the demersal trawl fauna from a range of sites. Cluster analysis revealed three distinct site assemblages: 'coastal', 'inshore', and 'inter-reef', characterized by the conspicuous abundance of some species and the absence of other species. The location of these assemblages was related to water depth, sediment particle size composition and distance offshore but could not be explained by the distribution of fishing effort. Some sites, intermediate in location between these assemblages, were assigned to a 'transitional' assemblage in which sites changed affiliation temporally.

□ trawl bycatch, demersal, reef, zonation, Great Barrier Reef.

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The inter-reef regions of the Great Barrier Reef (GBR) are the focus of an expanding prawn trawl fishery. This is a result of economic pressures on the heavily capitalized fleet to increase landings and the number of species and stocks exploited. All the fisheries of the GBR are subject to operating limitations and regulations imposed by the Great Barrier Reef Marine Park Authority. Although the inner shelf areas have been trawled extensively by commercial fishermen, our knowledge of the animal assemblages that inhabit these grounds is still relatively poor. As a consequence, present zoning of the reef for different uses by management authorities has been based more on socio-economic considerations than on biological ones.

Although Frankel (1978) listed some 4,500 literature citations from the GBR region, most of these dealt with the shallower coral reef environs. Only recently have studies dealing with the structure of tropical trawled communities of the Indo-Pacific appeared: in the Gulf of Papua (Kailola and Wilson, 1978; Watson, 1984), the northern Gulf of Carpentaria (Liu *et al.*, 1978), and the southern Gulf of Carpentaria (Rainer and Munro, 1982). In unpublished reports Goeden and Cannon (1980) described macrofauna from a small trawl grid across the GBR in the Cairns region, and Birtles *et al.* (1982) described fauna from a single trawl transect from the coast to the shelf edge off Townsville. Cannon *et al.* (1987) represent the first attempt made to describe community zonation of the inter-reef regions on a large scale.

Rainer and Munro (1982) reported on the

community zonation of the southern Gulf of Carpentaria, but restricted their analysis to fishes and cephalopods. Cannon *et al.* (1987) included most of the major macrofaunal groups (fishes, molluscs, echinoderms, crustaceans, cnidarians, and sponges) in their description of zonation patterns along the GBR. They showed that the broader taxonomic data set improved resolution of community types and suggested that some of the less mobile taxa might be good indicators of the effects of any increased trawling effort in the future. Both of these studies used non-replicated samples collected from a large number of sites so that examination of small scale spatial differences and the effects of seasonal variation was impossible.

The objective of our work was to provide baseline data sets that characterize inter-reef communities and their seasonality in areas recently exposed to fishing. An understanding of the inter-reef communities will allow assessment of potential problems caused by commercial trawling and allow construction of longer term management strategies for the Great Barrier Reef Marine Park.

MATERIALS AND METHODS

Twenty trawl sites were chosen in conjunction with a study of an existing prawn fishery on Queensland's continental shelf between 18°S and 20°S latitude (Fig. 1). They were positioned to provide a range of water depth, distance from shore, and to include sites throughout the range of the prawn fishery.

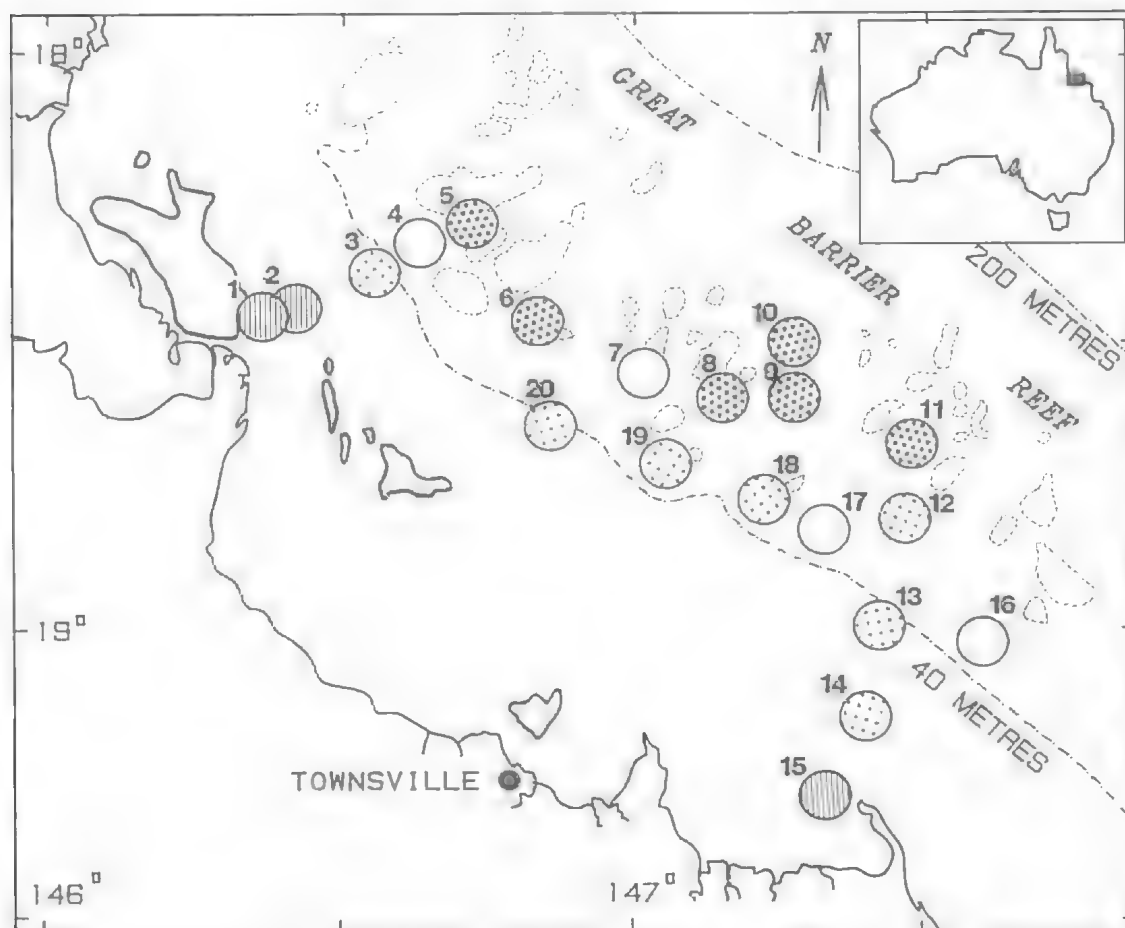


FIG. 1. Location of sampling sites showing their site assemblage affiliations: 'A' - coastal (strips), 'B' - inshore (small dots), 'C' - inter-reef (large dots), and transitional (clear).

Samples were obtained by trawling on consecutive nights, at or around the time of the new moon from a 20 m vessel each month from January 1985 through December 1985. Most sites were sampled 12 times (a single tow per site monthly) except for sites missed in February and March due to bad weather. Two 'Florida Flyer' nets, each with a 12 m headline length, were towed along the bottom following the depth contour for 30 minutes at approximately 6 km/hr. The samples were obtained from the starboard net which was constructed of 27 ply polypropylene, 50 mm stretch mesh which is standard for commercial trawlers in the northern prawn fishery. The port net had 40 mm mesh and fauna taken from it were not used in the present study except on the rare occasions (less than 3% of samples) when the starboard net failed.

Large, difficult-to-handle elements such as

sponges, sea snakes, and large elasmobranchs such as stingrays and shovel-nose sharks, were noted and discarded. The total catch from the starboard net was weighed and a random subsample of approximately 10 kg was taken and rapidly frozen. When thawed in the laboratory, all fishes, crustaceans, echinoderms, and molluscs were identified to species level. Taxa which could not be identified easily were forwarded to the Queensland Museum. All identifications of fishes, crustaceans and molluscs were eventually confirmed by the Queensland Museum. Taxa identifications were outlined in Jones and Derbyshire (1988).

Sediment samples of approximately one litre were collected from each trawl sampling site once during December 1985 using a Smith-McIntyre grab. In the laboratory, these samples were wet sieved into fractions with the following particle sizes: over 2mm, 2-1mm, 1-0.5mm, 0.5-0.25mm,

0.25-0.125mm, 0.125-0.063mm, and under 0.063mm.

Records of fishing effort were extracted from voluntary logbooks issued to 40 to 50 fishermen trawling between 18°S and 21°S. The records were expressed as hours trawled and catch landed within defined six by six minute areas. Average monthly effort in fishing hours per grid area from areas containing our trawl sites were used as a measure of fishing effort expended in the vicinity of our sample sites.

The SPSS package was used for the preliminary analyses of data and to calculate species frequencies. Species present in fewer than 5% of samples or whose identities were in doubt were omitted from subsequent analysis. For the remaining species, the numbers of individuals were standardized as the log base 10 of the total number caught in the starboard net per hour of trawling. These numbers are referred to as abundances. A commercial software package, CLUSTAN (University of Edinburgh, Scotland, 1978), was used to cluster trawl sites using abundance. The clusters of sites produced are referred to as site assemblages. Quasi-metric Bray-Curtis measures were calculated (Bray and Curtis, 1957) and a hierarchical fusion of the matrix was performed using Ward's method, also known as Error Sum of Squares (Ward, 1963). This combination of measure computation and fusion method was considered to yield good results (Abel and Williams, 1985) despite the traditional restriction of Ward's method to strictly metric measures. For comparison, other distance measures such as squared euclidean distance and average distance were used with Ward's, Lance-Williams' flexible Beta, and the Group Average methods, with similar results.

CLUSTAN was also used to produce dendrograms and diagnostics for each site assemblage. An assemblage was characterized by two groups of species: those species which were consistently abundant compared to the other assemblages (referred to as inherent); and those which were conspicuously absent while being generally abundant (consistently greater than 10 individuals) in other clusters (referred to as missing). CLUSTAN was also used to cluster sites based on their sediment particle size composition.

RESULTS

A catch of about 8 tonnes was landed. Approximately a quarter of this was sorted and counted. Included were 450 taxa from nine phyla, 13 classes, and 110 families. Only a very small proportion of

the material (less than 4%) has commercial value. Fishes constituted 38%, and crustaceans 42% of the individual animals taken in the samples. No species were present in every sample taken during the entire sampling period and the vast majority were present in fewer than 50% of samples. About 70% of the biomass of the catch consisted of small (10-20 cm total length) fishes and the majority of the balance were small crustaceans.

Dendrograms of the monthly classification of sites revealed consistent site assemblages (Fig. 2). With the possible exception of March, when many sites were missed due to bad weather, the 20 sites grouped monthly into three site assemblages (denoted 'A' coastal, 'B' inshore, and 'C' inter-reef) at a dissimilarity level of approximately 0.75. Of these assemblages, 'B' and 'C' were consistently more similar, that is, they clustered together sooner in the analysis. Although the exact relationships between the sites changed from month to month, the overall classification was remarkably consistent and only a small number of sites changed their assemblage affiliations (Fig. 2). A 'transitional' site was defined as one which was a member of a single site assemblage for less than 70% of the monthly samples obtained from that site. Four sites were transitional: 4, 7, 16, and 17. If the occurrence within a single site assemblage is restricted to 60% then there were only two transitional sites: 4 and 7. All transitional sites shared their monthly affiliations between assemblages 'B' and 'C'. Table 1 lists the monthly classification of sites and the proportion of occurrences within assemblages 'A', 'B' and 'C', as well as those designated as transitional.

Locations of the sampling sites together with their appropriate site assemblages are shown in Fig. 1. The transitional sites, 4 and 7, had the weakest site assemblage affiliations and were geographically close to coral reef complexes, unlike transitional sites 16 and 17. Although sites 18 and 19 were also located close to coral reefs, they were both clustered with assemblage 'B' in 89% of the monthly samples.

The general distribution of site assemblages roughly parallels the coastline (Fig. 1). Sites 1, 2 and 15 ('A') can be considered as 'coastal'; sites 3, 12, 13, 14, 18, 19 and 20 ('B') as 'inshore', and sites 5, 6, 8, 9, 10 and 11 ('C') as 'inter-reef'. The transitional sites 4 and 7 were approximately equally divided between 'inshore' and 'inter-reef' assemblages. Transitional sites 16 and 17 were primarily 'B' or 'inshore' sites (Table 1).

Monthly lists of inherent species for each of the three site assemblages were sorted and the species

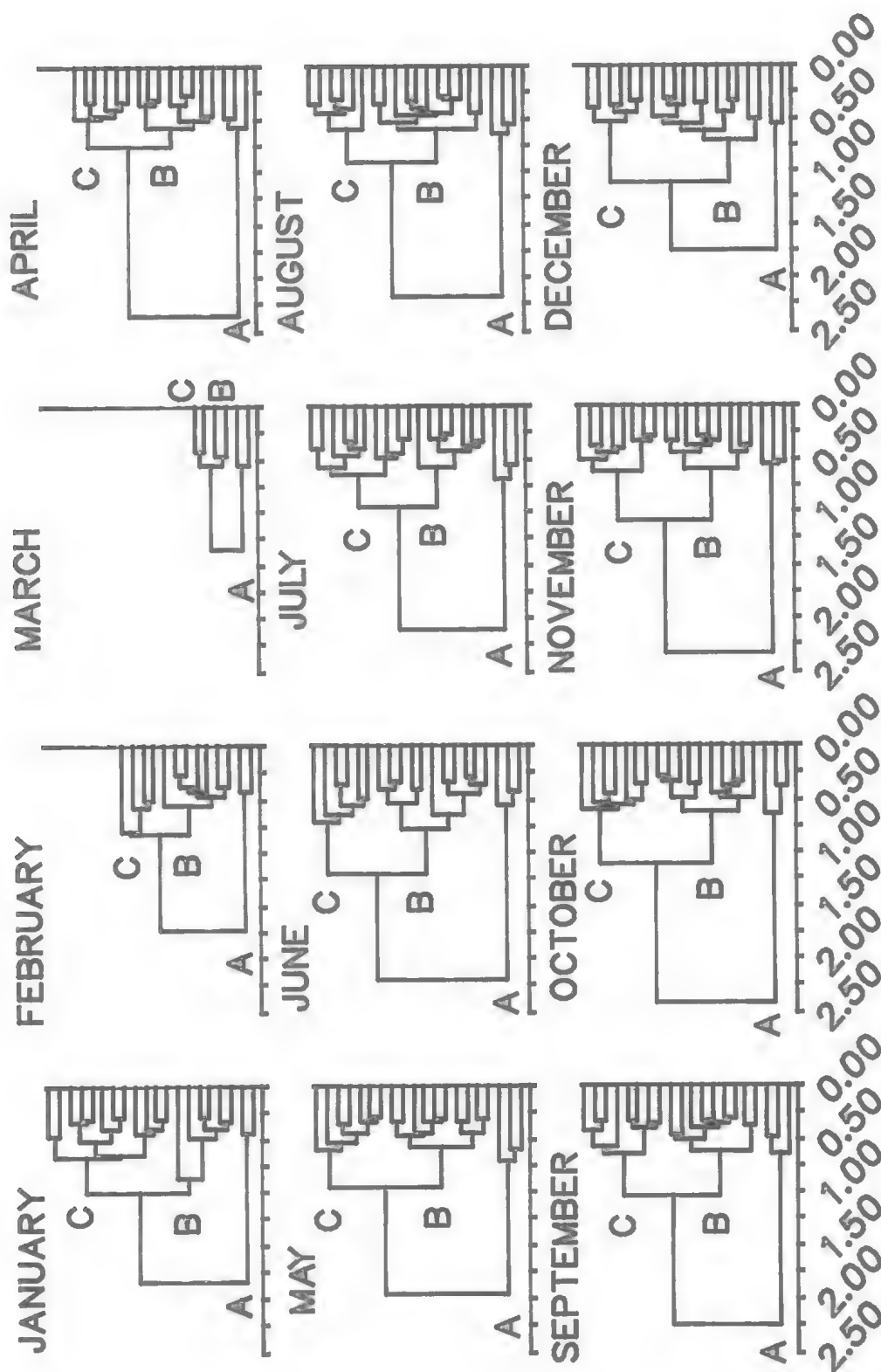


FIG. 2. Monthly dendrograms showing site assemblages resulting from the cluster analysis of sites based on species abundance. Site assemblages: 'A' - coastal, 'B' - inter-reef, and 'C' - inshore. The horizontal axes are dissimilarity indices and the vertical axes are site numbers.

TABLE 1. Classification of samples and sites. The monthly, total and overall classification of sites into site assemblages 'A' coastal, 'B' inshore, 'C' inter-reef, and those 'transitional' (indicated as B/C). Percent total occurrence appears in parentheses. Overall site assemblage classification and classification based on sediment analysis are included.

SITE	MONTH OF SAMPLE												TOTAL SAMPLES CLASSIFIED AS			OVERALL CLASSIFICATION	SEDIMENT GROUP
	J	F	M	A	M	J	J	A	S	O	N	D	'A'	'B'	'C'		
1	A	A	A	A	A	A	A	A	A	A	A	A	12 (100)	—	—	A	A
2	A	A	A	A	A	A	A	A	A	A	A	A	12 (100)	—	—	A	B
3	B	B	B	B	B	B	B	B	B	B	B	B	—	12 (100)	—	B	B
4	B	B	B	C	B	B	C	B	C	C	B	C	—	7 (58)	5 (42)	B/C	B
5	C	—	C	C	C	C	C	C	C	C	C	C	—	—	11 (100)	C	C
6	C	C	C	C	C	C	C	B	C	C	C	C	—	1 (8)	11 (92)	C	C
7	C	B	—	B	B	B	C	C	C	C	C	B	—	5 (45)	6 (55)	B/C	C
8	C	C	—	C	C	C	C	C	C	C	C	C	—	—	11 (100)	C	C
9	B	B	—	C	C	C	C	C	C	C	C	B	—	3 (27)	8 (73)	C	C
10	B	C	—	C	C	C	C	C	C	C	C	C	—	1 (9)	10 (91)	C	C
11	C	—	—	B	C	C	C	C	C	C	C	C	—	1 (10)	9 (90)	C	C
12	B	B	—	B	B	B	B	B	B	B	B	B	—	11 (100)	—	B	B
13	B	B	—	B	B	B	B	B	B	B	B	B	—	11 (100)	—	B	C
14	B	B	—	B	B	B	B	B	B	B	B	B	—	11 (100)	—	B	B
15	B	C	—	A	A	A	A	A	A	A	A	—	8 (80)	1 (10)	1 (10)	A	A
16	C	—	—	B	C	B	C	B	B	B	B	B	—	7 (70)	3 (30)	B/C	B
17	C	—	—	B	B	B	C	B	B	B	C	B	—	7 (70)	3 (30)	B/C	C
18	C	—	—	—	B	B	B	B	B	B	B	B	—	8 (89)	1 (11)	B	C
19	C	—	—	—	B	B	B	B	B	B	B	B	—	8 (89)	1 (11)	B	C
20	C	—	—	—	B	B	B	B	B	B	B	B	—	8 (89)	1 (11)	B	B
	20	13	6	17	20	20	20	20	20	20	20	19	32 (15)	102 (47)	81 (38)		
	TOTAL SAMPLES IN MONTH																

ranked in order of their frequency of appearance on monthly lists. Only those which were listed as inherent at that site assemblage for five or more months appear in Table 2. The site assemblages can be characterized by those species that were missing. Table 3 ranks species that were missing from each site assemblage in five or more monthly samples.

From Table 3 we note that only *Orbonymus rameus* was common to lists of missing species from assemblages 'A' and 'C' and that only *Amusium pleuronectes* was common to lists of missing species from assemblages 'B' and 'C'. *Upeneus* sp. 1 was missing from assemblage 'A' throughout the entire 12 month sampling period.

Assemblage 'A' had noticeably more species missing (20) from five or more sample months during the study than did assemblages 'B' (5) or

'C' (9)(Table 3). Species common to 'B' and 'C' were often missing from 'A' which contributed to the greater dissimilarity of 'A' in classification analysis (Fig. 2). This should not, however, be confused with species richness; of the nearly 200 species included in the analysis, 82% occurred in site assemblage 'A' compared with 80% for 'B' and 70% for 'C', even though the latter two contained double the number of sites.

Commercially valuable animals, though possibly present, were generally not inherent to any site assemblage on a regular basis. The scallop, *Amusium pleuronectes*, was inherent in site assemblage 'A' for nine of the 12 months. By comparison the coral prawn, *Metapenaeopsis palmensis*, was inherent for only five months, and the brown and grooved tiger prawns, *Penaeus esculentus* and *P. semisulcatus*, were inherent for

TABLE 2. Inherent species characterizing site assemblages based on and ranked by the number of times they were inherent in five or more monthly samples. Parentheses enclose the number of months in which the species was inherent at that site assemblage. Taxa are represented by (B) Bivalvia, (C) Cephalopoda, (M) Malacostraca (Crustacea), and (O) Osteichthyes.

Assemblage 'A'	Assemblage 'B'	Assemblage 'C'
B <i>Amusium pleuronectes</i> (9) M <i>Charybdis truncata</i> (9) O <i>Apogon poecilopterus</i> (7) O <i>Repomuscenus belcheri</i> (7) M <i>Portunus pelagicus</i> (6) M <i>Metapenaeopsis palmensis</i> (5) O <i>Nemipterus hexodon</i> (5) O <i>Priacanthus tayenus</i> (5) O <i>Terapon theraps</i> (5)	M <i>Portunus rubromarginatus</i> (11) O <i>Hypodytes carinatus</i> (9) O <i>Parapercis nebulosa</i> (9) O <i>Engyprosope grandisquama</i> (8) O <i>Paramonacanthus japonicus</i> (6) C <i>Sepia</i> spp. (6) O <i>Dactyloptena papilio</i> (5) O <i>Synodus similis</i> (5) O <i>Torquigener tuberculiferus</i> (5)	M <i>Portunus argentatus</i> (9) O <i>Nemipterus c.f. marginatus</i> (9) O <i>Saurida undosquamis</i> (7) O <i>Trachinocephalus myops</i> (7) O <i>Upeneus</i> sp. 1 (5)

TABLE 3 Missing species characterizing site assemblages based on and ranked by the number of times they were absent from five or more monthly samples. Parentheses enclose the number of months in which the species was missing from that site assemblage. Taxa are represented by (A) Ascidiacea, (B) Bivalvia, (C) Cephalopoda, (E) Echinoidea, (M) Malacostraca (Crustacea), and (O) Osteichthyes.

Assemblage 'A'	Assemblage 'B'
O <i>Upeneus</i> sp.1 (12) M <i>Penaeus longistylus</i> (11) O <i>Trachinocephalus myops</i> (11) O <i>Synodus similis</i> (10) E <i>Mareia planulata</i> (9) O <i>Sorsogonia tuberculata</i> (9) O <i>Lepidotrigla calodactyla</i> (8) O <i>Nemipterus celebicus</i> (8) B <i>Amusium balloti</i> (7) O <i>Hypodytes carinatus</i> (7) O <i>Parapercis nebulosa</i> (7) O <i>Inimicus caledonicus</i> (6) O <i>Pseudorhombus duplicicellatus</i> (6) A <i>Zooanthus</i> sp. 1 (6) O <i>Calliurichthys grossi</i> (5) O <i>Choerodon</i> sp. 1 (5) O <i>Orbonymus rameus</i> (5) M <i>Portunus tenuipes</i> (5) O <i>Synodus sageneus</i> (5) O <i>Torquigener tuberculiferus</i> (5)	B <i>Amusium pleuronectes</i> (9) M <i>Charybdis truncata</i> (7) O <i>Priacanthus tayenus</i> (6) O <i>Arnoglossus waitei</i> (5) O <i>Nemipterus hexodon</i> (5) M <i>Penaeus semisulcatus</i> (5)
	Assemblage 'C'
	O <i>Dactylopus dactylopus</i> (7) B <i>Amusium pleuronectes</i> (5) O <i>Apogon poecilopterus</i> (5) M <i>Charybdis jaubertensis</i> (5) O <i>Lethrinus nematacanthus</i> (5) M <i>Metapenaeopsis lamellata</i> (5) O <i>Orbonymus rameus</i> (5) O <i>Repomuscenus belcheri</i> (5) E <i>Temnotrema bothryoides</i> (5)

four months. The commercial species, red-spot king prawns, *P. longistylus*, and the scallop, *A. balloti*, were inherent to site assemblage 'C' during only four of the 12 months sampled. Assemblage 'B' contained no currently commercial species which were consistently inherent.

There was a significant difference (chi-square, $p < .05$) in the proportions of samples taken from 'transitional' sites (Table 1) classified as 'B' and those classified as 'C' during the 'wet' season months (Feb-Jun) (87% 'B' and 13% 'C') compared with those taken during the 'dry' season months (Jan, Jul-Dec) (46% 'B' and 54% 'C'). There were, however, no significant (chi-square) differences in the proportions of other sites clas-

sified as 'A', 'B' or 'C' between the 'dry' and the 'wet' seasons.

SEDIMENT GRAIN SIZE

Cluster analysis of the grain size composition of the sediments at each sampling site produced the dendrogram shown in Fig. 3. By choosing the same dissimilarity level (0.75) that was used to differentiate species assemblages based on species abundance, the sediment analysis also separated the sites into three major groups. There is a 75% overlap between the distribution of the sites among the site assemblages based on sediment composition and those based on species abundance (Table 1). The inclusion or exclusion of the transitional

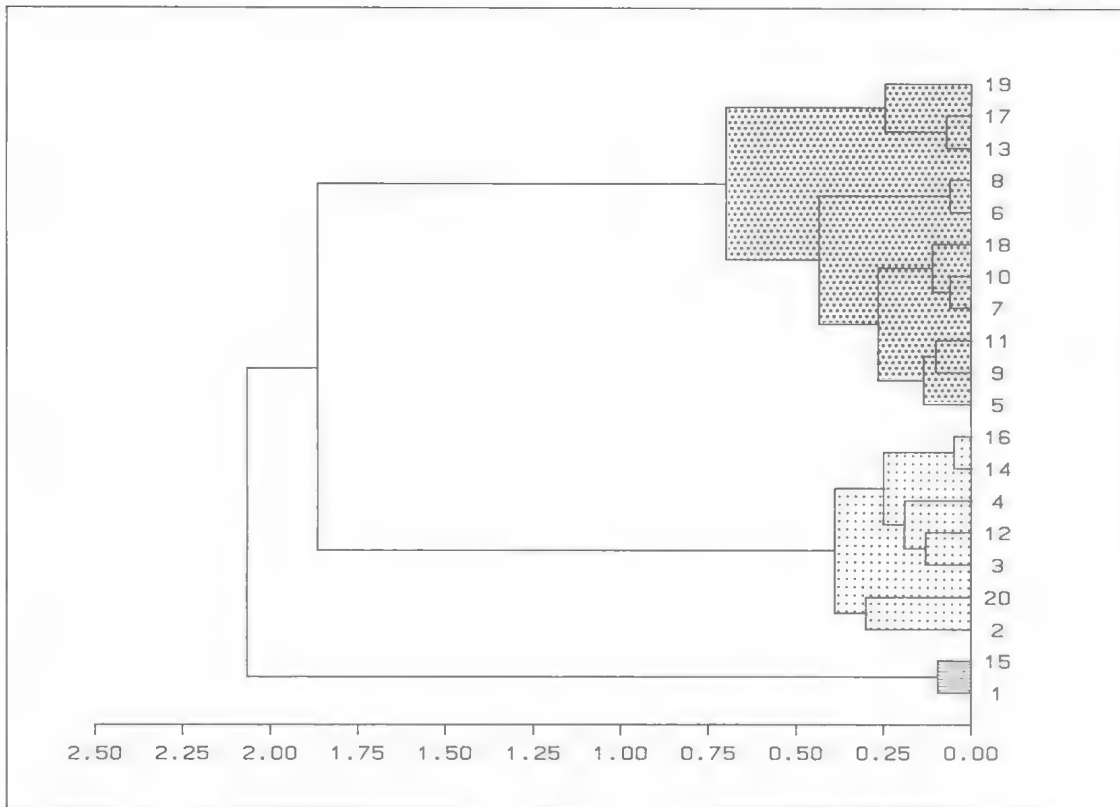


FIG. 3. Dendrogram resulting from cluster analysis of sites based on sediment particle size distribution. Site assemblage affiliations: 'A' - coastal (strips), 'B' - inshore (small dots), and 'C' - inter-reef (large dots). The horizontal axis is the dissimilarity index and the vertical axis are site numbers.

sites had no effect on the level of overlap when they were ranked according to their most common species assemblage affiliations.

Fig. 4 shows the distribution of grain sizes among the three site assemblages. The 'coastal' assemblage ('A') was characterized by fine mud (<0.063 mm), the 'inshore' assemblage ('B') by coarser sediments ($1-0.125$ mm), and the 'inter-reef' assemblage by fine sediments ranging down to mud ($0.25-0.063$ mm). Sediments at the transitional sites were the same as those of the 'inshore' assemblage.

SEDIMENT CARBONATE LEVELS

Maxwell (1968) described the general distribution of carbonate sediment for much of the GBR region. Sediment with high carbonate levels (80%-100%) was considered to be reefal in origin while sediment with low carbonate levels (20% - 40%) was considered to be terrigenous. Using Maxwell's (1968) sediment distributions and classifications, the site assemblages based on species

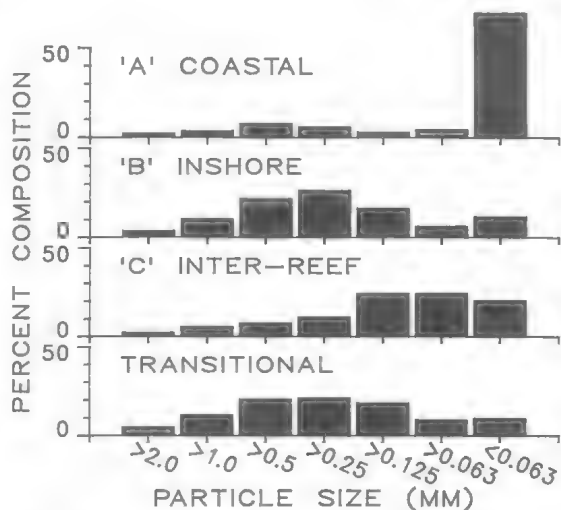


FIG. 4. Distribution of sediment particle sizes within site assemblages: 'A' - coastal, 'B' - inshore, 'C' - inter-reef and, transitional.

abundance separate out well according to carbonate content (Table 4).

DEPTH OF TRAWL SITE

The site assemblages could also be separated according to the depth of each sampling site (Table 5). Percentage overlap in the distribution of sites grouped with the 'inshore' assemblage versus the 'inter-reef' assemblage based on sediment types (Table 4), and that based on depth ranges (Table 5) was the same with the transitional assemblages omitted (14%), as it was with the transitional assemblages distributed between 'inshore' and 'inter-reef' assemblages according to their strongest affiliation (20%).

FISHING EFFORT

In general the average commercial trawling hours recorded from logbook grid areas containing study sites was low during the 1984-85 period (Table 6). The average fishing efforts for 84/85 on

the 'inshore' and 'inter-reef' assemblages were similar. This was 5-6 times that of the 'coastal' assemblage but only half that recorded for sites in the transitional assemblage (Table 6).

DISCUSSION

Our results showed three distinct site assemblages based on species abundance. Because each site demonstrated considerable variability in species abundances from one monthly sample to the next, consistency of classification was obtained at higher levels of dissimilarity, that is, at broader levels of community description.

The occurrence and distribution of these three zones supports the work of Cannon *et al.* (1987) who used extensive trawling techniques over most of the GBR region. Their work covered a total of 229 essentially random sites from which approximately 700 species were collected. Each site was, however, sampled only once and thus temporal trends could not be investigated. Similarly, Rainer

TABLE 4. The carbonate content of sample sites within the site assemblages. Numbers are the numbers of sites.

% Carbonate (after Maxwell, 1968)	Number of Sites in Site Assemblage			
	'Coastal'	'Inshore'	'Transitional'	'Inter-Reef'
0-20	—	—	—	—
20-40	3	—	—	—
40-60	—	—	—	—
60-80	—	6	2	—
80-100	—	1	2	6

TABLE 5. The depth range of sample sites within the site assemblages. Numbers are the numbers of sites.

Depth Range (depth in m)	Number of Sites in Site Assemblage			
	'Coastal'	'Inshore'	'Transitional'	'Inter-Reef'
0-12	—	—	—	—
13-24	3	—	—	—
25-36	—	2	—	—
37-48	—	4	2	—
49-60	—	1	2	6

TABLE 6. Average monthly commercial fishing effort from site assemblage sites in hours per grid area from those 6' by 6' grids that included sample sites. Percentage of monthly average effort from each site assemblage is shown in parentheses. Data from 1984 covers the period August to December only.

Site Assemblage		Monthly Commercial Fishing Effort (h)		
		1984	1985	Average 84/85
Coastal	A	0.67 (2.4)	1.25 (6.2)	0.96 (4.0)
Inshore	B	1.70 (6.1)	10.36 (51.7)	6.03 (25.2)
Inter-reef	C	7.04 (25.3)	2.11 (10.5)	4.58 (19.1)
Transitional		18.39 (66.2)	6.32 (31.6)	12.36 (51.7)
Total		27.80	20.04	23.93

and Munro (1982) found broad zones paralleling the coast in the Gulf of Carpentaria and concluded that there were distinct inshore and offshore species assemblages.

We were able to characterize each zone in the central GBR by the conspicuous abundance or absence of particular species. Lists of species missing from each zone were not indicative of species richness but of faunal similarity. More of the species recorded from the study area were found at the 'coastal' site assemblage than at the 'inshore' or 'inter-reef' assemblages even though the 'coastal' assemblage had more conspicuously missing species than the latter two assemblages.

Though the distribution of commercial fishing effort prior to and during this study may be associated with the differences in the rank order of some species between the 'coastal' site assemblages and those further offshore, it fails to explain the differences between the 'inshore' and 'inter-reef' site assemblages, which recorded variable but similar overall fishing effort. Differences in fishing effort distribution do not explain why the 'transitional' sites, which had more than double the fishing effort of the 'inshore' and 'inter-reef' sites, clustered monthly with either the 'inshore' or 'inter-reef' sites. It is possible that the greater fishing effort expended at 'transitional' sites may have influenced the seasonal changes in species abundance which caused these sites to change affinity between the 'inshore' and 'inter-reef' assemblages from month to month. The presence and distribution of the site assemblages can be more readily linked, however, with depth and sediment composition than with the distribution of fishing effort.

The results of our study suggest that both temporal and physical factors play a role in establishing the distribution of species assemblages. We found that sediment and depth were equally related to the species zonation pattern but speculate that sediment may be more important in determining the distribution of demersal and benthic organisms. Penaeid prawn distribution is influenced by both sediment composition and depth in northern Australia (Somers, 1987).

Individual species may well react to summer/winter changes through an extension or contraction of range, but there was only minimal evidence to support the phenomenon at the assemblage level. There was, however, a shift of assemblage boundaries (the 'transitional' sites) which could be related to the wet and dry seasons of the Queensland tropical coast. It must be kept in mind that only about 20% of the sites were classified as

'transitional' and so the effect must be viewed as very weak relative to that of depth and sediment type.

Rainer (1984) concluded that trawled communities in the Gulf of Carpentaria were basically depth-related but did show some seasonal shift to deeper regions in September compared with March. Rainer (1984) concluded that his 1960s data portrayed a fish and cephalopod community in continual flux. Further research trawling in 1983 (Poiner and Harris, 1985), after 20 years of exposure to commercial fishing, revealed that 'the site groups for each month . . . conform reasonably well with the patterns (inshore and offshore) detected by Rainer (1984)'. Extensive trawling within the GBR region led Cannon *et al.* (1987) to conclude from the agreement between their data and both Gulf studies that 'the inshore/offshore pattern is a stable one despite slight seasonal changes or others created by the advent of commercial trawling'.

Three site assemblages: coastal, inshore and inter-reef could be characterized by bycatch species. In our study most of the species occurred at some time in each site assemblage and no species were present throughout the whole year. The collection of species that defined each site varied; but the grouping of sites that defined the assemblages remained relatively constant. Thus the assemblages, although reasonably consistent in structure, are characterized by their dynamic nature and by flexible boundaries that move as the fauna responds to subtle environmental changes or move to meet their particular life-cycle requirements. They do not seem to have the rigidity that would be maintained through the slower acting effects of inter-specific competition.

Future work could make more detailed study of representative sites from the three site assemblages to determine the scale of inter-annual variation and to monitor any changes induced to benthic substrates and benthic community structure by commercial trawling.

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